RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 44 MARCH 1945 No. 3

Carcinoma of the Cheek, Alveolar Processes, Floor of the Mouth, and Palate[1]

RICHARD H. BEISWANGER, M.D., and K. WILHELM STENSTROM, Ph.D.

Minneapolis, Minn.

STATISTICAL studies indicate that 7 per cent of all fatal cancers in man originate in the oral region (1). With the present facilities for diagnosis and treatment, it seems that this figure should be appreciably reduced. These neoplasms are readily detected and, when seen early enough, are not too difficult to cure. Yet, as will be shown later, most of the patients when first seen present lesions which have extended beyond their original confines. As a result, the five-year cure rate remains discouragingly low, despite definite advances in therapy. For an extensive review of the history of this subject, the reader is referred to Albright's article, published in 1935 (2).

The present study includes carcinoma of the cheek, alveolar processes, floor of the mouth, and hard and soft palates. During the years 1926 to 1940, inclusive, 160 cases of carcinoma arising at these sites were referred to the Section of Radiation Therapy, University of Minnesota Hospitals, for treatment. All were followed in the Out-Patient Clinic, and when a patient failed to return to the Clinic, letters were sent to the family physician or relatives. Only one case remained untraced.

In 129 of the 160 cases the diagnosis was established by biopsy. The remaining 31 patients either had no biopsy or, if biopsy was done, the report was unavailable. The two groups will be considered separately in discussing the results of treatment.

CLASSIFICATION

The cases in this series are divided into six sub-groups according to the location of the growth, as follows: carcinoma of the upper alveolar process, 21 cases; of the lower alveolar process, 34 cases; of the cheek, 58 cases; of the floor of the mouth, 27 cases; of the hard palate, 12 cases; of the soft palate, 8 cases.

The lesions have also been grouped clinically, according to their extent, as follows:

Stage I. Under 1.5 cm. in diameter..2 cases (1%)
Stage II. Over 1.5 cm. in diameter with no local extension.....34 cases (21%)
Stage III. With local extension....54 cases (34%)
Stage IV. With metastases on admission.....70 cases (43%)

Howes and Bernstein (3), using a somewhat similar classification, report 9 per cent of 138 cases as of Stage I, 33 per cent Stage II, 9 per cent Stage III, and 57 per cent Stage IV. It will be noticed that in 43 per cent of our series metastases were present on admission, and in 77 per cent the disease had extended beyond its original confines either by local extension or metastasis or both.

[1] From the Department of Radiology and Physical Therapy of the University of Minnesota and the University Hospitals, Minneapolis, Minn. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

TABLE I: ETIOLOGIC FACTORS IN ORAL CARCINOMA

Site	Total No. of Cases	Use of Strong Tobacco	Leukoplakia	Ill-fitting Dentures	Sharp Teeth
Alveolar processes	55	11 (20%)	10 (18%)	12 (21%)	2 (4%)
Cheek	58	15 (26%)*	16 (27%)	4 (7%)	6 (10%)
Floor of mouth	27	7 (26%)†	4 (15%)	6 (22%)	0
Palate	20	2 (10%)	3 (15%)	2 (10%)	0

* 13 of 15 chewed tobacco. † 4 of 7 chewed tobacco or used snuff.

ETIOLOGY

Cancer of the oral cavity is predominantly a disease of old age. The average age in our series was 65 years, the age range being from 36 to 88 years. Two patients were between 30 and 39; 8 between 40 and 49; 35 between 50 and 59; 51 between 60 and 69; 47 between 70 and 79; 12 over 80. In 5 the age was undetermined. Martin and Pflueger (4) report an average age of 59 in 99 cases of cancer of the cheek seen in the Memorial Hospital, New York. The average age for all intraoral cancer in that hospital is given by Martin and Sugarbaker (5) as 57 years.

Of our patients, 19 (12 per cent) were females and 141 males (88 per cent).

Chronic irritation is an obvious etiologic factor. The most common irritants are sepsis, dental appliances, syphilis, and the stronger forms of tobacco, such as are present in chewing tobacco, snuff, pipe tobacco, and cigars. Lund (6), discussing the cause and prevention of buccal cancer writes: "Normally the mucous membrane of the mouth is comparatively resistant to the development of cancer as shown by the fact that women, who very largely do not chew tobacco or smoke pipes and whose mouths average much cleaner, in other ways than men's, have buccal cancer but one-eighth as frequently as men." Davis (7) attributed the prevalence of carcinoma of the cheek in the Philippine Islands to the chewing of *buyo*, which is a combination of buyo leaf, betel nut, slaked lime, and tobacco. This habit is more common among women than men and the incidence of carcinoma of the cheek in the Philippines is higher among women.

Quick (8), discussing leukoplakia and allied mouth conditions, states that "local sepsis of chronic character is also underrated in its probable relation to cancer. Tissue specimens from chronically infected gum margins show all the changes from simple hypertrophy to beginning downgrowth of the basal layer in an irregular papillary manner and ultimately to fully developed cancer."

Figi (9) states that carcinoma of the mouth often develops adjacent to carious teeth and ill-fitting dentures. On the other hand, such growths are encountered infrequently in edentulous persons and, when they do occur, are almost always of an inactive type. He considers the role of tobacco still debatable.

Fraser (10) of Edinburgh, writing in *Annals of Surgery*, states the case as to sepsis quite clearly: "Mouth infection is the most constant and prevailing associated influence, and we have no doubt that it plays a highly significant part in the production of the malignant error. An analysis shows that at least 50 per cent of the cases were infected with pyorrhea alveolaris prior to the development of the cancer, and from what we have seen, we are satisfied that this influence is one of the most significant in the etiological picture, that it is the most common and constant factor, and that its influence is increased when it is combined with other irritant factors such as alcohol, tobacco, syphilis or direct local irritation."

Table I lists the possible causes of cancer in this series. Dental sepsis was present in 95 per cent. Among tobacco users we have included only those using the stronger forms for a long period of time. Ill-fitting dentures have been considered as a factor only when irritation from this cause ex-

tended over a long period, ten to twenty years in most cases, never under five years. In this connection, it is interesting to note that in 6 of the 19 females of the series, *i.e.*, 31 per cent, an ill-fitting dental plate was considered to be the causative factor. In 69 cases no possible cause was recorded other than sepsis. Information was lacking in some of the charts, and it is probable that the tobacco habit played a greater role than the figures indicate. The incidence of syphilis was low—8 cases or 5 per cent. Syphilis is a more important factor in cancer of the tongue. Associated intra-oral leukoplakia occurs most commonly on the cheek, 27 per cent in this series. Its incidence closely parallels the use of strong tobacco. Martin and Pflueger (4) report leukoplakia present in 22 per cent of carcinomas of the cheek.

HISTOLOGY

The tumors, except for two adenocarcinomas of the hard palate, were all of squamous-cell origin.

SYMPTOMS

The average duration of symptoms before the institution of treatment was 8.6 months. Carcinoma of the oral cavity, like all carcinoma, is symptomless in the earliest stages. One-half the patients complained of pain as the first symptom, which indicates that the lesion had been present for some time; the other half complained of an ulcer, local swelling, or enlarged cervical lymph nodes.

The more malignant lesions first appear as small indurated ulcers or fissures in the mucosa. As the lesion penetrates, pain increases and finally becomes continuous. The more benign lesions usually appear as a papillary mass, often developing on an area of leukoplakia. Their growth is slow and there is not the early tendency to invasion or spread by cervical metastasis shown by the ulcerative lesion.

In time, the lesions grow deeper and become necrotic. Those involving the cheek are stretched and those elsewhere in the mouth are irritated by the ingestion of food and the movements of mastication. The cheek may be perforated, and lesions invading the pterygoid or temporal muscles will cause trismus. Carcinomas of the floor of the mouth remain infected because of poor drainage. Infection is followed by pain and swelling. Hemorrhage by erosion of an artery may occur. Death results from several causes—infection, hemorrhage, malnutrition.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis is not too difficult. A biopsy should be done in every case. Other diseases which may form ulcers on the intra-oral mucosa are syphilis, tuberculosis, superficially ulcerated or fissured leukoplakia, herpes, and simple granulomas (as that caused by trauma), Vincent's angina, etc. Only after repeated negative biopsies for carcinoma may some syphilitic lesions be differentiated. Then, if the Wassermann reaction is positive and the lesion responds to two or three weeks of intensive antisyphilitic treatment, carcinoma may be ruled out. The two diseases commonly co-exist.

The base of the ulcer in tuberculosis is yellowish, as compared to the coarse beefy appearance of the cancerous lesion. A tuberculous ulcer occurs most commonly on the tongue. In this case, biopsy fails to reveal cancer and tuberculosis can almost always be found elsewhere.

Fissured leukoplakia may be diagnosed by biopsy and treated by cautery or radiation. It is advisable to do a biopsy on any ulcer that persists for more than two weeks.

METASTASES

Of 146 patients, 104 (70 per cent) had palpable nodes on admission; in 14 the presence or absence of palpable nodes was not recorded. In 73 (70 per cent) of the 104 cases, the nodes were proved to be metastatic, either by the subsequent clinical course or microscopically. Table II gives the number of cases with metastases at the time of admission, grouped according to site.

TABLE II: PRESENCE OF METASTASES IN ORAL CARCINOMA

Location of Primary Lesion	No. of Cases	Cases with Metastases on Admission	Percentage of Metastases	Cases with Metastases Developing after Admission
Upper alveolus	18	7	40%	1
Lower alveolus	23	8	35%	0
Cheek	49	27	55%	4
Floor of mouth	21	9	43%	2
Hard palate	10	3	30%	2
Soft palate	8	5	73%	0

TREATMENT

It is well to decide whether treatment is to be an attempt at cure or merely palliative. There are three distinct problems: (1) hygienic care of the oral cavity before, during and after treatment; (2) treatment of the primary lesion; (3) management of cervical metastases.

General Hygienic Measures: In the type of patients we receive for treatment, the mouth is generally in poor condition. All broken, jagged, infected teeth, as well as all teeth in the proposed field of irradiation, should be immediately extracted. Daily mouth washes or saline irrigations are advised, and the patient should learn how to use a toothbrush. Necessary vitamin therapy should be prescribed, and the use of tobacco discouraged.

Treatment of the Primary Lesion: Treatment of the primary lesion is by surgery with subsequent irradiation, irradiation with subsequent surgery, or irradiation alone. In some of our cases the surgical bed was immediately implanted with 0.3 mm. gold-filtered radon implants. Others were referred for radiation therapy by the surgeon because the entire lesion could not be excised or because of recurrence. In recent years most cases have been referred directly from the tumor clinic for irradiation.

Since the period covered by this review extends from 1926 to 1940, these patients have been treated in various ways. Radon has been used extensively, however, in almost all the cases, including the early ones. Treatment now usually consists in the local application of radium molds (primary lesion) and external irradiation (x-rays) over a period of twenty-one to twenty-eight days. Gold radon implants are then inserted into soft-tissue lesions and around metastatic nodes. If any persistence is noticed two months later, a radical dissection is advised in operable cases. The factors for external irradiation are: 220 kv., 15 ma., usually 60 cm. target-skin distance, with 0.5 to 1.0 mm. Cu plus 1.0 mm. Al filter. Multiple fields are treated, usually three, sometimes four, 200 to 300 r in air being given to one field daily until a definite dermatitis is produced on the skin. By these methods approximately 3,000 (x-ray) r and 4,000–7,000 (gamma) r are delivered to the lesion. Martin, Quimby and Pack (11) have shown that it takes 7,000 to 10,000 gamma-ray roentgens delivered in ten to twenty days to destroy epidermoid cancer.

The treatment of the cervical nodes, as well as special treatment to the different sites, will be discussed more fully below.

Different clinics favor different methods of getting the lethal dose to the center of the tumor. Regaud (12) prefers to use intratumoral radium needles, arguing that these provide a more constant source of radiation. Berven (13) of the Radiumhemmet (Stockholm) uses teleradium with subsequent electrocoagulation, or surface application of radium to the primary tumor and as a preliminary to dissection of the cervical nodes if these are involved. Grier (14) objects to radium needles, as likely to introduce infection. He uses them only in the tongue and tonsils, and then for only a short period.

Treatment of Cervical Metastases: There is a considerable difference in the incidence of metastases from the various regions of the oral cavity. According to Nathanson and Taylor (15), the mobility of the part appears to be a factor in the production of cervical metastases. Thus there is a higher incidence of metastases from the mobile tongue, floor of the mouth, and soft palate than from the comparatively rigid hard

palate and gingivae. It is possible that the continuous massaging of the primary cancer in these areas favors dissemination. The incidence of metastatic spread is less from the anterior third of the cheek than from that part which overlies the masseter muscle, where the lesion is continuously massaged by the movements of mastication.

The stage of the disease as well as the extent of the growth influences the occurrence of metastases. If all cases were left untreated, all would no doubt ultimately metastasize. When the carcinoma spreads to neighboring structures, it may be spreading not only to a part of the oral cavity from which metastases are more likely to occur, but it also gains access to a greater number of lymphatic channels. The grade of malignancy of the lesion, as well as the type of growth, ulcerative and invasive or papillary, is of course an extremely important factor in the incidence of metastasis.

Distant metastases are rare in oral cancer, the disease rarely extending below the clavicles. Usually relatively few nodes are involved unless the tumor has reached an inoperable stage. Bilateral metastases, however, are not uncommon.

Dissection of involved cervical nodes is indicated, according to Duffy (16), only if the primary lesion is controlled; if it is limited to one side of the oral cavity and is of highly differentiated cell type; if the metastases are limited to a single group of nodes or to nodes in two contiguous cervical triangles; if the capsule of the node is not infiltrated by carcinoma; if the opposite side of the neck is free of metastases and no distant metastases are present, and if the patient is in good general condition.

Control of the primary lesion is the first requisite in treatment, since its recurrence will surely result in recurrence of metastases, either on the same or opposite side of the neck. If no metastases are present, control of the primary tumor will prevent their subsequent development and prophylactic neck dissection will not be necessary.

TABLE III: RESULTS OF TREATMENT IN CASES WITH CERVICAL METASTASES

Site	No. of Cases	5-year Cures	Treatment
Upper alveolar process	6	2	Radiation and surgery
Lower alveolar process	5	0	
Cheek	21	1*	Radiation
Floor of mouth	6	0	
Hard palate	2	0	
Soft palate	3	0	
Total	43	3 (7%)	

* Clinical.

Lesions which extend to or beyond the mid-line are usually large and of a high degree of malignancy and therefore hard to control. Small lesions, however, may extend across the mid-line, and such extension should not of itself contraindicate neck dissection. Neither should a high grade of malignancy alone necessarily exclude dissection. If the cancer is highly malignant, however, there are usually other contraindications as well.

In general, we agree with Duffy that dissection is not indicated unless metastases are actually present. Some patients, however, harbor metastases which cannot be diagnosed clinically. Others have cervical nodes which appear to be involved but at operation are found to be merely hyperplastic. The percentage of error in this respect, as given by Duffy (16), varies from 15 to 35 per cent, *i.e.*, one-sixth to one-third of nodes showing signs suggestive of cancer are found to be hyperplastic. If all are subjected to neck dissection, many unnecessary operations will be done and there will be some postoperative deaths. This disadvantage must be weighed against the fact that some with actual but not clinically evident involvement will have the benefit of early neck dissection.

We have not advised prophylactic neck dissection but have followed our cases very closely, once every four weeks for six months, and every two months thereafter for two years.

Table III gives the results of treatment in cases with cervical metastases. These cases were treated with external irradiation, radon implantation, and block dis-

section of cervical nodes when indicated. Far-advanced cases were given palliative treatment only. Almost all patients, whether with or without cervical metastases, received some irradiation to the cervical region at the time the primary lesion was treated. If metastases were thought to be absent, the dose to the neck was somewhat less than that given to the primary lesion. If metastases were thought to be present, block dissection was done where not contraindicated. If block dissection was contraindicated and treatment was not purely palliative, external irradiation was given to the cervical region to the limit of skin tolerance and radon seeds were then implanted around the involved node or nodes for a total dosage of 7,000 to 10,000 gamma ray and x-ray roentgens. Palliation of varying degree and duration was obtained in practically all cases.

Treatment of Cervical Metastases at Other Clinics: Hayes Martin (17) believes that one or two erythema doses to each side of the neck are probably of no value. He uses fractionated roentgen irradiation, including only the node and a surrounding area of 1.5 cm. He gives 4,000 to 8,000 r in two or three weeks, then 5 to 10 T.E.D. by radon. He believes radiation treatment of the entire lymph-bearing area to be dangerous and holds that better results will be obtained by treating each node separately. For small nodes radon seeds are sometimes enough. Some authors have stated that there are no authentic cures of cervical metastases by radiation. Martin (17) reports 46 five-year cures in cases where the presence of metastases was proved by aspiration biopsy.

Albright (2) refers to Mekie's series (1932) of 268 collected cases of mouth cancer with metastases to the cervical nodes (his own cases and those of Forssell and Quick); only 8 (3 per cent) were cured. Albright also cites Simmons' experience. This latter writer, in 376 cases of mouth cancer, reported 5 per cent surgical cures in patients with clinical metastases and none by radiation (admittedly inadequate in dosage). Forssell, also quoted by Albright, reported 72 cases with neck metastases with no cures by radiation. Judd and New (18) in 1927 reported 5 per cent surgical cures in carcinoma of the oral cavity with lymph node metastases.

COMPLICATIONS

Hemorrhage may occur because of erosion of the facial or external maxillary artery. Ligation of the external carotid artery on the affected side may be necessary.

Healing may be delayed because of *local necrosis* of soft tissue. Such local necrosis is more apt to occur if the facial artery is severed during a neck dissection.

When extensive radiation is applied to bone, *radiation necrosis* may result. It is thought that this is due to interference with the circulation. This subject is adequately covered in a fairly recent article by Watson and Scarborough (19). According to their report, this complication developed in 48 (40 per cent) of 121 patients with carcinoma of the alveolar ridge treated at Memorial Hospital, in 62 (34 per cent) of 180 with tumors in the floor of the mouth, and in 37 (25 per cent) of 149 with carcinoma of the cheek. They believe that the present protracted method of irradiation is less damaging.

In our series of 160 cases treated, 14 (9 per cent) suffered from osteoradionecrosis. The highest incidence (14 per cent) followed treatment to lesions of the lower alveolar process. The average time which elapsed between the beginning of treatment and the development of necrosis of bone was eight months. The longest interval was two years.

Treatment is conservative. The patient may have to be fed with a nasal catheter because of painful swallowing, trismus, or salivary fistula. Frequent mouth irrigations are recommended. It may be necessary to inject the involved sensory nerves with alcohol. Sequestra are removed when possible. After sequestration and removal of bone splinters, pain usually disappears promptly. Resection of the mandible is dangerous if attempted late, as evidenced

TABLE IV: RESULTS OF TREATMENT IN CARCINOMA OF THE ALVEOLAR PROCESSES, CHEEK, FLOOR OF MOUTH, HARD AND SOFT PALATES—ALL CASES

Year	No. of Cases	Years of Survival														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1926	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1
1927	7	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
1928	4	4	1	1	1	1	1	1	1	1	1	0	0	0		
1929	9	7	2	1	1	1	0	0	0	0	0	0	0			
1930	2	1	1	1	1	1	1	0	0	0	0	0				
1931	9	3	2	2	2	2	1	1	1	1	1					
1932	16	14	10	7	7	7	7	5	5	3						
1933	19	9	7	6	5	5	4	3	3							
1934	7	4	2	2	1	1	1	1								
1935	13	7	4	0	0	0	0									
1936	9	7	3	3	3	3										
1937	13	11	10	8	3											
1938	12	8	6	4												
1939	13	10	6													
1940	24	14														
Cases	160	160	136	123	111	98	89	76	69	50	34	25	23	14	10	3
Survival		103	58	39	28	24	16	12	11	6	3	1	1	1	1	1
Per cent		64	42	32	25	24	18	16	16	12	10	4				
Lost		1 (Considered no survival)														

by the report by Watson and Scarborough (19) of 22 per cent mortality in their series of 51 cases.

The incidence of radiation necrosis can be materially reduced by the adoption of a few preventive measures. The mouth must be kept clean. Loose or carious teeth should be extracted before radiation therapy, and devitalized or decalcified teeth may be extracted or ground down to the alveolar margin and root canals filled. Some go so far as to extract all teeth, sound or unsound, in the proposed field of irradiation. Portals should be selected which will avoid bone as much as possible.

When radium is used, the uninvolved parts can be partially protected by incorporating lead in the mold. Resection of that part of the bone most prone to develop this complication shortly after completion of therapy is advocated by some.

RESULTS OF TREATMENT

Table IV gives the results in all cases referred to the department for treatment, while Table V gives the results of treatment in cases proved by biopsy. Both tables show the same five-year survival rate, 24 per cent, indicating that clinical judgment as to the presence of a malignant process, in the absence of a biopsy, was accurate. For the results of treatment at the different sites, only those cases with a positive biopsy will be included. The five-year survival (free of disease) for patients without metastasis was 15 out of 33, or 45 per cent.

Carcinoma of Upper Alveolar Process (Positive Biopsy): There were 18 cases of carcinoma of the upper alveolar process with positive biopsy. Among 15 cases treated up to and including 1936 there were 7 (47 per cent) five-year survivals. Six of the 15 patients had metastases at the time of admission. Two of the 6 with metastases are among those surviving five years. In the other 4 with metastases, the disease was not controlled. Nine of those treated up to and including 1936 had no metastases on admission. In one of these metastases developed and death occurred after two years with disease. Five of the 9 survived five years or longer.

Most of these lesions are extensive when first seen and are therefore best treated by a combination of radiation and some form of surgical diathermy. Some may be controlled by radiation alone.

Treatment by radiation consisted of external irradiation supplemented by radon

TABLE V: RESULTS OF TREATMENT IN CARCINOMA OF THE ALVEOLAR PROCESSES, CHEEK, FLOOR OF MOUTH, HARD AND SOFT PALATES—CASES PROVED BY BIOPSY

Year	No. of Cases	Years of Survival															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Living
1926	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1
1927	5	1	1	1	1	0	0	0	0	0	0	0	0	0	0		
1928	3	3	1	1	1	1	1	1	1	1	1	0	0	0			
1929	5	4	1	0	0	0	0	0	0	0	0	0	0				
1930	2	1	1	1	1	1	1	0	0	0	0	0					
1931	8	3	2	2	2	2	1	1	1	1	1						1
1932	10	9	5	4	4	4	4	3	2	2							2
1933	15	9	6	5	4	4	4	3	3								3
1934	7	3	1	1	1	1	1	1									1
1935	9	6	4	0	0	0	0										
1936	8	6	3	2	2	2											1
1937	11	9	7	5	4												4
1938	10	6	5	3													3
1939	12	11	6														6
1940	21	14															14
Cases	129	129	108	96	86	75	67	58	51	36	26	18	16	11	8	3	36
Survival		88	46	28	23	18	13	10	8	5	3	1	1	1	1	1	
Per cent		70	42	30	26	24	20	17	16	14	11						
Lost		1 (Considered no survival)															

implants and/or application of radium incorporated in a dental mold. In the later years external irradiation was given to two or three overlapping fields, 200 to 300 r daily for twenty to twenty-eight days, to the limit of skin tolerance. Almost all lesions received 5,000 to 9,000 gamma-ray roentgens from the radon implants. Some were treated first with a radium mold, 3 to 5 T.E.D., then with external irradiation and usually radon, also.

Recurrences usually were treated with more radon and external irradiation. If there was extension to the antrum, the antrum was opened and the tumor removed surgically. One to four radium capsules were then packed in the cavity, depending upon its size. The dose was 500 to 2,500 mg.-hours in ten to thirty hours, depending upon the number of capsules used. The capsules contained 25 mg. of radium each, filtered with 2 mm. of brass. Treatment to the cervical nodes has been discussed.

Table VI gives results at other clinics.

Carcinoma of Lower Alveolar Process (Positive Biopsy): There were 23 cases of carcinoma of the lower alveolar process with positive biopsy. Thirteen cases were treated up to and including 1936, with 5 (38 per cent) five-year survivals. Five of the 13 patients had metastases at the time of admission. None of these lived two years after the onset of treatment and all died with disease. (Two who did not have a biopsy had positive clinical evidence of metastases and were alive after five years.) Eight of the 13 patients had no metastases on admission. In 6 of these the disease was controlled; 5 lived over five years free of disease, and one four years.

Ten patients were treated after 1936; 7 had no metastases on admission; 3 had metastases. In none did metastases appear later. Of the 7 with no metastases, 4 are living and free of disease, 1 three years, 1 two years, and 2 one year. Three of these four were treated by radiation alone. None of the 3 with metastases lived two years after beginning treatment.

If the carcinoma has invaded the mandible, surgery is the method of choice. If all the tumor cannot be excised, supplementary radiation in the form of radon implants and external radiation should be given. Many of these patients are poor surgical risks and these should be given intensive irradiation unless the prognosis is utterly hopeless. If radionecrosis does occur, the affected portion of the mandible can be excised before too much pain ensues.

TABLE VI: RESULTS OF TREATMENT IN CARCINOMA OF THE UPPER ALVEOLAR PROCESS

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Holmgren (20)	39	25% (5 years)	Surgical
König (20)	48	16% (5 years)	Surgical
Martens (20)	79	20% (5 years)	Surgical
Welch (21)	137	17% (5 years)	Mostly surgical
New and Figi (22)	295	43% (5 years)	Surgical diathermy and radiation
Lund and Holton (23)	34	12% (5 years)	Radiation and surgery
Hautant (20)	18	38% (1½–5 years)	Radiation and surgery
Barnes (20)	25	52% (1–9 years)*	Radiation and surgery
Green (20)	36	33% (1–5 years)	Radiation and surgery
New (20)	97	36% (1–8 years)	Radiation and endothermy
Lierle (24)	16	31% (3–7 years)	Radiation
Berven (20)	44	18% (4 years)	Radiation and surgery
Author	15	47% (5 years)	Radiation and surgery

* Cases without metastases only.

TABLE VII: RESULTS OF TREATMENT IN CARCINOMA OF THE LOWER ALVEOLAR PROCESS

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Simmons (25)	14	26% (5 years)	Surgery alone
Welch and Nathanson (21)	237	12.5% (5 years)	Mostly surgery
Geschickter (26)	Representative group	25% (5 years)	Surgery with little radiation
Lund and Holton (23)	68	15% (5 years)	Mostly surgery
New and Figi (22)	87	40% (5 years)	Surgery and radiation
Berven (20)	61	18% (5 years)	Radiation and endothermy
Regaud (20)	Representative group	16% (5 years)	Radium
Author	12	38% (5 years)	Radiation and surgery

When there is no invasion of the mandible, irradiation is preferred, as a rule, since these lesions show a good response. There are some cases, however, with no invasion of the mandible where surgery may be the method of choice, that is, small lesions with metastases to the submaxillary or upper cervical nodes. In such cases, dissection of the lesion and involved nodes can be done in one stage. Early localized lesions are probably equally well controlled by irradiation and by surgery, but irradiation is a less formidable procedure.

We have treated these lesions by external irradiation and radon implants in the same manner as lesions of the upper alveolar process. Some of the cases were treated with the radium dental mold plus external irradiation as previously described.

Carcinoma of the Cheek (Positive Biopsy): There were 49 cases of carcinoma of the cheek with positive biopsy. Five (18 per cent) five-year survivals were obtained in 28 cases treated up to and including 1936. Of these 28 patients, 21 had metastases at the time of admission, while 1 with no metastases on admission developed metastases later. One with metastases survived five years. Seven of those patients treated up to and including 1936 had no metastases on admission. Four of these are included among the five-year survivals.

Twenty-one cases were treated after 1936—6 (30 per cent) with metastases (compare this with 75 per cent with metastases before 1936) and 15 with no metastases. Three of those with no metastases had metastases later. Of the 6 with metastases, 2 are living over two years free of disease (both had unilateral neck dissections) and the remaining 4 died with cancer. Ten (48 per cent) of the 21, including those with metastases, are free of disease, 3 for four years, 1 for three years, 4 for two years (1 died of intercurrent disease), and 2 for one year. All are alive but the one indicated.

The above figures show that 75 per cent of the cases treated before 1937 had metas-

TABLE VIII: RESULTS OF TREATMENT IN CARCINOMA OF THE CHEEK

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Steiner (Martin and Pflueger, 4)	33	9% (3 years)	Surgery
Morestin (4)	26	11% (3 years)	Surgery
Geschickter (26)	Representative group	10% (5 years)	Surgery and radiation
Welch and Nathanson (21)	300	22% (5 years)	Surgery and radiation
Berven (4)	81	26% (5 years)	Radiation and surgery
Forssell (25)	160	30% (5 years)	Surgery and radiation
Pfahler (28)	177	27% (5 years)	Radiation and surgery
Lund and Holton (23)	69	16% (5 years)	Radiation and surgery
Schreiner and Simpson (4)	30	20% (5 years)	Radiation only
Regaud (4)	47	19% (5 years)	Radiation only
Martin, C. L. (29)	40	30% (5 years)	Weak radium needle technic
Martin and Pflueger (4)	99	30% (5 years)	Radiation and surgery
Author	28	18% (5 years)	Radiation and surgery

tasized at the time of admission, compared to only 30 per cent of those seen from 1937 to 1940, inclusive. The number of cases treated during the two periods was approximately equal. Since our five-year survival rate must be taken from cases treated before 1937, this explains the rather low five-year survival rate of 18 per cent.

In our experience this has been a difficult condition to treat. Most lesions were treated with radon implants, with doses of 7,000 to 10,000 gamma-ray roentgens to the center of the tumor, plus external irradiation. Some were given 500 to 800 mg. hours with the radium mold plus external irradiation.

Results of treatment by surgery alone have not been encouraging. Small early lesions in the anterior portion of the cheek are amenable to surgery. Lesions further back are more prone to metastasize and are best treated by a combination of radiation and surgery or radiation alone. Most of the lesions were extensive when first seen and the incidence of metastases was high (55 per cent), higher than for any other site except the soft palate (70 per cent). The lesion also frequently extended to areas such as the lateral pharyngeal wall or palate, inaccessible to surgery. Albright (2) quotes Pólya, who, "with wide experience in plastic surgery of this region, warns that extensive removal of the buccal mucous membrane leads to scar formation, contraction, and inability to open the mouth."

Table VIII gives results of treatment from other clinics.

Carcinoma of the Floor of the Mouth (Positive Biopsy): There were 21 proved cases of carcinoma of the floor of the mouth, with only one (9 per cent) five-year survival among 11 cases treated up to and including 1936. This patient had a Stage II lesion and was treated by radiation alone. Six (54 per cent) of the 11 patients had metastases on admission, and all of these died with disease. Five had no metastases on admission. One of these died after six years, free of disease, and one after two years; another died in less than a year but free of disease. After 1936, 10 cases were treated—3 with metastases and 7 with no metastases. The resulting figures are naturally more encouraging. Three with metastases died with disease. Of the 7 with no metastases, 1 is living four years free of disease, 1 two years, 2 one year.

Most authors admit inoperability of these lesions unless they are 1 cm. or less in diameter. Larger lesions are inoperable because of extension to the tongue and mandible. Radiation therapy is indicated, since it is less mutilating and gives better results. Radiation was given through portals over the rami of the mandible and to the floor of the mouth from below. In some instances a cone was used to irradiate the lesion directly through the mouth. The amount of radiation which can be given is limited because of the danger of osteoradionecrosis. External radiation was supplemented by radon implants and/or radium mold. The best results were obtained in the Stage II lesions; treatment

TABLE IX: RESULTS OF TREATMENT IN CARCINOMA OF THE FLOOR OF THE MOUTH

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Geschickter (26)	Not stated	20% (5 years)	Surgery
Lund and Holton (23)*	58	14% (5 years)	Mostly surgery
Welch (21)	250	8% (5 years)	Surgery and radiation
Pfahler (28)†	25	16% (5 years)	Radiation
Regaud (5)	77	22% (5 years)	Radium
Martin and Sugarbaker (5)	103	25% (5 years)	Radiation and surgery
Berven (20)	32	34% (5 years)	Teleradium and endothermy
Author	11	9% (5 years)	Radiation and surgery

* Cases with small nodes not necessarily malignant. † Figures revised to compare with ours.

was without effect on the Stage IV lesions. Since large lesions of the floor of the mouth usually cross the mid-line, cervical metastases in such cases are almost always bilateral, which partially explains the poor prognosis in Stage IV.

Table IX gives results of treatment from other clinics.

radium mold were used. Extension to the antrum was treated as previously described.

Table X gives results of treatment from other clinics.

Carcinoma of the Soft Palate (Positive Biopsy): There were 8 cases of carcinoma of the soft palate with positive biopsy.

TABLE X: RESULTS OF TREATMENT IN CARCINOMA OF THE HARD PALATE

Reported by	No. of Cases	Per Cent Cures	Method of Treatment
Welch (21)	174	19% (5 years)	Mostly surgery
Geschickter (26)	Not stated	10% (5 years)	Surgery
Lund and Holton (23)	42	14% (5 years)	Mostly surgery
Lierle (24)	9	22% (5–7 years)	Radiation and surgery
Pfahler (28)	76	20% (5 years)	Radiation
Regaud (26)	Not stated	4% (5 years)	Radium

Carcinoma of the Hard Palate (Positive Biopsy): There were 10 cases of carcinoma of the hard palate with positive biopsy. No five-year survivals were obtained in the 6 cases treated up to and including 1936. Two (20 per cent) of 10 patients treated up to and including 1939 are alive after three years. Of the 6 patients treated before and including 1936, 2 had metastases on admission, in 2 metastases developed later, and 2 were without metastases. One lived over three years, but all died with disease. After 1936, 4 cases were seen, 3 with no metastases and 1, an adenocarcinoma, with metastases. One of the patients with no metastases lived over three years and died free of disease. He was treated by radiation only.

Carcinoma of the hard palate is best treated by a combination of surgery and radiation. Surgery in our cases consisted of electrocoagulation of the lesion. External irradiation, radon implants, and the Three of these were among those treated up to and including 1936. All 3 had metastases and none lived as long as a year. They were given palliative treatment only. Five patients were seen after 1936; 2 with metastases lived less than one year. The 3 with no metastases were treated in 1940, and all are living and free of disease.

SUMMARY AND CONCLUSIONS

1. A review has been presented of 129 cases of carcinoma of the alveolar processes, cheek, floor of the mouth and palate, with positive biopsy. The five-year survival rate of 24 per cent compares favorably with survival rates reported from other clinics. In addition, the survival rates for each site have been reported separately and various data as to treatment, complications, etc., have been included.

2. By the proper use and control of radiation alone, or radiation and surgery combined, good results can be obtained in

Stage I, Stage II (no local extension), and Stage III (local extension but no metastases) lesions. Sixty-one per cent of Stage II lesions and 60 per cent of Stage III lesions were controlled for one to five years in this series.

3. Better results may be expected in the future: (*a*) for the primary lesion by the increased use of direct intra-oral therapy in combination with the present methods of irradiation, and possibly by the more generalized use of higher kilovoltages, up to 400 kv.; (*b*) for cervical metastases by possibly more vigorous radiation in combination with surgery for operable metastases and by more localized and, therefore, more intense irradiation of inoperable metastases; (*c*) in general, by education of the public, dentist, and physician in regard to early recognition of the malignant lesion.

421 Michigan
Toledo 2, Ohio

BIBLIOGRAPHY

1. LOGSDON, C. M.: Malignancy of the Oral Cavity Region. J. Am. Dent. A. **26:** 879–883, June 1939.
2. ALBRIGHT, H. L.: Carcinoma of the Mouth with Especial Reference to Treatment. Radiology **25:** 24–45, July 1935.
3. HOWES, W. E., AND BERNSTEIN, L.: Oral Carcinoma. Radiology **37:** 468–475, October 1941.
4. MARTIN, H. E., AND PFLUEGER, O. H.: Cancer of the Cheek (Buccal Mucosa): Study of 99 Cases with Results of Treatment at the End of Five Years. Arch. Surg. **30:** 731–747, May 1935.
5. MARTIN, H. E., AND SUGARBAKER, E. D.: Cancer of the Floor of the Mouth. Surg., Gynec. & Obst. **71:** 347–359, September 1940.
6. LUND, C. C.: Epidermoid Carcinoma of the Buccal Mucosa. Surg., Gynec. & Obst. **66:** 810–813, April 1938.
7. DAVIS, G. G.: Buyo Cheek Cancer, with Special Reference to Etiology. J. A. M. A. **64:** 711–718, Feb. 27, 1915.
8. QUICK, D.: Leukoplakia and Allied Mouth Conditions. Canadian M. A. J. **40:** 234–239, March 1939.
9. FIGI, F. A.: Malignant Diseases of the Mouth. J. Am. Dent. A. **26:** 1979–1986, December 1939.
10. FRASER, J.: Carcinoma of Mouth and Tongue. Ann. Surg. **96:** 488–514, October 1932.
11. MARTIN, H. E., QUIMBY, E. H., AND PACK, G. T.: Calculations of Tissue Dosage in Radiation Therapy (A Second Report). Am. J. Roentgenol. **25:** 490–503, April 1931.
12. REGAUD, C.: Radium Therapy of Cancer at the Radium Institute of Paris: Technique, Biological Principles and Results. Am. J. Roentgenol. **21:** 1–24, January 1929.
13. BERVEN, E. G. E.: Operative and Radiological Treatment of Malignant Tumours of the Mouth. Acta radiol. **8:** 473–537, 1927.
14. GRIER, G. W.: Treatment of Malignant Diseases of the Mouth. Am. J. Roentgenol. **12:** 347–352, October 1924.
15. TAYLOR, G. W., AND NATHANSON, I. T.: Lymph Node Metastases: Incidence and Surgical Treatment in Neoplastic Disease, New York, Oxford University Press, 1942, p. 136.
16. DUFFY, J. J.: Treatment of Cervical Nodes in Intra-oral Cancer. Surg., Gynec. & Obst. **71:** 664–671, November 1940.
17. MARTIN, H. E.: Treatment of Cervical Metastatic Cancer. Ann. Surg. **114:** 972–985, December 1941.
18. JUDD, E. S., AND NEW, G. B.: Carcinoma of the Tongue. Surg., Gynec. & Obst. **36:** 163–169, February 1923.
19. WATSON, W. L., AND SCARBOROUGH, J. E.: Osteoradionecrosis in Intraoral Carcinoma. Am. J. Roentgenol. **40:** 524–534, October 1938.
20. BERVEN, E. G. E.: Development of Technique and Results of Treatment of Tumors of the Oral and Nasal Cavities. Am. J. Roentgenol. **28:** 332–343, September 1932.
21. WELCH, C. E., AND NATHANSON, I. T.: Life Expectancy and Incidence of Malignant Disease: Carcinoma of the Lip, Oral Cavity, Larynx and Antrum. Am. J. Cancer **31:** 238–252, October 1937.
22. NEW, G. B., AND FIGI, F. A.: Malignant Diseases of the Mouth, Pharynx and Larynx—5-Year Cures. Surg., Gynec. & Obst. **60:** 483–484, February (2A), 1935.
23. LUND, C. C., AND HOLTON, H. M.: Cancer of the Buccal Mucosa: End Results 1918–1926. New England J. Med. **208:** 775–780, April 13, 1933.
24. LIERLE, D. M.: Epidermoid Carcinoma of the Pharynx, Buccal Mucosa and Larynx. Ann. Otol., Rhin. & Laryng. **48:** 875–885, December 1939.
25. PADGETT, E. C.: Results and Prognosis of Cancer in and about the Oral Cavity. Internat. J. Orthodontia **22:** 1255–1267, December 1936.
26. GESCHICKTER, C. F.: Tumors of the Oral Mucous Membrane. Am. J. Cancer **26:** 586–607, March 1936.
27. DRESSER, R., AND DUMAS, C. E.: Radiation Treatment of Carcinoma of the Buccal Cavity. Am. J. Roentgenol. **36:** 939–945, December 1936.
28. PFAHLER, G. E.: Treatment of Carcinoma of Lip and Mouth. Radiology **35:** 598–605, November 1940.
29. MARTIN, C. L.: Weak Radium Needle Technique in Carcinoma of the Cheek. Am. J. Roentgenol. **43:** 226–236, February 1940.

Streamlining X-Ray Therapy for Wartime Service[1]

CAPT. ALBERT SOILAND (MC) U.S.N.R.

Assistant to Inspector, Naval Medical Department Activities, Pacific Coast
U. S. Naval Hospital, Long Beach, Calif.

SOME FORTY-SEVEN years ago, while still an undergraduate, the writer operated a static machine for Dr. H. G. Brainerd of Los Angeles, with which he essayed x-ray diagnosis and conducted experiments with treatment. One day Dr. John B. Murphy of Chicago appeared with a colleague suffering from pain in the kidney, with purulent and bloody urine. Doctor Murphy, suspecting stone, asked if we could make a diagnosis and we made a heroic attempt. An hour's exposure was made, but the x-ray plate was not diagnostic. Another exposure of one and a half hours' duration gave a faint shadow of the spine and abdominal organs, but this was still not sufficient for diagnosis. A few days later the patient's pain had ceased and pus and blood were no longer present in the urine. Within two weeks' time Doctor Murphy pronounced him symptom-free. In other words, it appeared that a therapeutic effect, entirely unexpected, had been achieved. Fortunately, no untoward sequelae developed on the skin or elsewhere, which we now know was due to the absence of quantitative long-wave radiation. This incident awakened a lasting respect for the possibilities of radiation therapy, which leads to the subject at hand; namely, streamlined radiation therapy for present wartime service.

Bridging the time since radiation therapy took its first faltering footsteps, let us briefly review its present-day status as a healthy young adult, acclaimed and acknowledged in all intellectual medical centers as a highly specialized and integral part of the practice of medicine. It is futile at present to dream of or await the arrival of multimillion-volt x-ray equipment. This is well on the way and in due time will find its ultimate place in radiation therapy. Meanwhile, let us correlate known facts and factors and adopt a common-sense, middle-ground working technic.

Equipment for x-ray therapy may now be accepted as standard, provided it is obtained from a manufacturer of known repute. All such apparatus, irrespective of name, can be integrated and made adaptable for any or all types of therapy which time and experience have proved effective. Many pioneer radiologists have, over a long period of years, placed x-ray therapy upon a solid and sane foundation.

The essentials for the average x-ray therapy department are as follows: low-voltage apparatus with a maintained capacity for 100 kv. at the tube's target; high-voltage apparatus with a maintained capacity for 200 kv. at the tube's target; adequate space for placing transformers, control cabinets, connecting lines, treatment tables, and necessary equipment, so as to facilitate therapeutic procedures to the best possible advantage.

Particular care must be exercised in providing effective protection from back-scattering, stray radiation, and potential direct or indirect radiation.

Cones and filters are necessary adjuvants to x-ray therapy and play a major role in securing accuracy of dosage for the prescribed number of roentgens to be administered. In our Los Angeles Tumor Institute we have standardized our cones and filters so as to take a conservative position between extremes. Skin and superficial treatments are coned to a skin-target distance of 30 cm. under 100-kv. generators; filters vary from 1 mm. of aluminum to 0.25 mm. of copper, according to desired depth and intensity. Adenopathies and

[1] Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

The opinions and assertions contained herein are the writer's. They are not official nor do they reflect the views of the Medical Department of the U. S. Navy.

other superficial pathologic conditions are coned to 50 cm. skin-target distance under 200-kv. generators, with 0.5 to 1.0 mm. copper filter. All deeply located conditions are also coned to 50 cm. skin-target distances with heavier filters to suit higher voltages.

One hundred- and 200-kv. x-ray generators are available everywhere, and the international dose equivalent is expressed in roentgens by the accepted sign "r." We are submitting herewith tables showing a suggested alignment of voltage, amperage, cones, target-skin distance, filters, and time factors, which, together with proper calibration and known r output per minute, will provide a basis for accurate dosage available to all military facilities where radiation therapy is utilized.

X-RAY THERAPY FACTORS FOR 100 AND 200 KV. IN USE AT THE LOS ANGELES TUMOR INSTITUTE

High Voltage

Kv. 200
Ma. 4
T.S.D. 50 cm.
Filters
  0.5 mm. Cu + 1.0 mm. Al
  1.0 mm. Cu + 1.0 mm. Al
Cones
  2 cm. diameter, 3 cm. diameter } Round cones for intra-oral use
  5 × 5 cm.
  10 × 10 cm.
  10 × 15 cm.
  15 × 15 cm.
  20 × 20 cm.

All cones contain 1.0 mm. of aluminum, so that this part of the filter cannot be omitted.

Low Voltage

Kv. 100
Ma. 4
T.S.D. 30 cm.
Filters
  1.0 mm. Al
  2.0 mm. Al
  3.0 mm. Al
  4.0 mm. Al
  0.25 mm. Cu + 1.0 mm. Al
Cones
  1 cm. diameter, 2 cm. diameter, 3 cm. diameter } Round cones for intra-oral use
  5 × 5 cm.
  10 × 10 cm.
  15 × 15 cm.

All cones contain 1.0 mm. of aluminum, so that it is impossible to give a treatment without filter.

In our own clinic we have found this method satisfactory over a long period of time. It must not be overlooked, however, that we are still unable to measure the

SAMPLE CALIBRATIONS OF FORMULAE GIVEN

High Voltage

Kv. 200
Ma. 4
T.S.D. ..... 50 cm.

Filter	r/min.
0.5 mm. Cu + 1.0 mm. Al	15
1.0 mm. Cu + 1.0 mm. Al	10

Low Voltage

Kv. 100
Ma. 4
T.S.D. ..... 30 cm.

Filter	r/min.
1.0 mm. Al	55
2.0 mm. Al	40
3.0 mm. Al	32
4.0 mm. Al	27
0.25 mm. Cu + 1.0 mm. Al	16

These sample calibrations have been certified by frequent checking. It is suggested, however, that every hospital where radiation therapy is a major activity secure the services of a full-time physicist.

patient, his own personal disease, his reactions to radiation, and his idiosyncrasies. The final results still depend very largely upon the man behind the gun.

This is the first time in American history that our sailors and soldiers have fought fanatical enemies under the worst climatic conditions this world affords, conditions to which white men are not inured. From the inconceivably bitter cold of the Aleutians to the enervating heat of the tropics, our men are coming home in steadily increasing numbers with pathological conditions of unknown origin and sinister aspect. The American medical profession will, as always before, meet and successfully cope with this emergency. From the Arctic will come new problems in the care of respiratory infections, skin injuries with trophic changes, frost-bite, and the more serious sequelae of frozen extremities. From the jungle new and more malignant types of malaria, poisons from hosts of insects and crawlers of many varieties hitherto unfamiliar, blood diseases, anemias, bizarre adenopathies, gastro-intestinal disturbances, skin and surface infections.

All this is in addition to the maimed and wounded patients. Here we find pain, inflammation, infection, and sometimes malignant growth, alone or in perplexing

Figs. 1 and 2. Keloids with infection following gasoline burns and results of radiation therapy a year later.

combination, and this is where teamwork on the part of all the staff of the hospital is paramount. Here, also, is where radiation therapy will exert its best influence, and the writer earnestly urges all hospital radiologists to co-operate.

Since my return to active duty, a large number of casualties have been observed at various naval hospitals on the west coast. Thus, sufficient time has elapsed to substantiate the good effect of radiation therapy, particularly in the acute inflammatory varieties of skin involvement, whether from trauma or infection, or both.

For brevity's sake, the following paragraph is quoted from a former article, "The X-Ray in the Treatment of Infection" (1):

"In looking over past case records in our own service, the following formidable array of pathologic conditions has been submitted to radiation therapy with considerable success: osteomyelitis, chondritis, dermatophytosis; acne vulgaris; furunculosis; carbuncles; ringworm; sycosis barbae; paronychia; lupus vulgaris; lupus erythematosus; erysipelas; mycosis fungoides; molluscum contagiosum; granuloma inguinale; trachoma; seborrheic dermatitis; otorrhea; mastoiditis; rhinophyma; acne rosacea; rhinoscleroma; verrucae; actinomycosis; coccidioidosis; inflamed tonsils; pertussis; pneumonia; empyemic sinuses; bronchiectasis; mastitis; pruritus; condyloma; chronic salpingitis; tubercular salpingitis; encephalitis; brachial neuritis; sciatica and radiculitis."

A number of dermatologists, and not a few radiologists, advocate unfiltered x-ray therapy. While in skillful hands and under strict regulation this is permissible, yet in the writer's opinion the use of raw radiation should be discouraged. There are altogether too many chances for excessive dosage from the unscreened tube, which can easily be avoided by employing selective filters. In fact, the tendency today is to step up both voltage and filter factors, not only for depth dosage but in treating skin and superficial disease, also. This has been strikingly demonstrated, in our past records, upon extensive surface lesions wherein supervoltage therapy was successful in clearing up certain conditions which had become static to cautery and

Figs. 3 and 4. Infected angioma of the scrotum in an infant before and a year after radiation therapy. The child is now (1944) ten years old and entirely normal.

ordinary x-ray and radium applications. In any event, radiation therapy is available in practically all military hospitals with men well versed in its use. Therefore, there appears to be no plausible excuse for not getting full service from this singularly effective therapeutic entity.

Dr. Neville Finzi, Director of the X-ray Department of St. Bartholomew's Hospital, and President of the Radiological Section, Royal Society of Medicine, London, in a recent article (2), writes: "With the very small doses now employed by some radiologists it is possible to carry on treatment, if necessary, for very long periods without the slightest risk of after-effects: this necessity, of course, arises only in the most chronic inflammations. Success has been obtained by ray therapy in such diverse conditions as carbuncle, erysipelas, suppurative parotitis, tuberculous glands, tuberculous peritonitis, actinomycosis, chilblains, whitlow, gas gangrene, osteomyelitis, and many others.

"In wounds there are two purposes to which irradiation can be put. One is the acceleration of the healing of clean wounds and the prevention of keloid; the other is to check the local inflammatory reaction, if there is no foreign body or sequestrum present. It does not matter whether the infection is acute, subacute or chronic, except that one tends to use even smaller doses in acute cases."

In conclusion, may I request that radiologists take cognizance of the fact that strong influences are at work to discredit x-ray therapy? How can these be combated? Our American journals devoted to the science of Radiology have over the past thirty years given incontrovertible proof of the singular efficacy of radiation therapy. Perhaps the medical profession at large is not interested in our subject matter. Our diagnostic radiologists are perhaps becoming lethargic or lazy. Certainly our surgical confreres by and large are not over-enthusiastic in extending their support. Whatever the factors at work, some concerted action could well be inaugurated to insure for radiotherapy the recognition it deserves.

REFERENCES

1. SOILAND, ALBERT: X-Ray in Treatment of Infection. Am. J. Surg. **42:** 798–803, December 1938.
2. FINZI, N. S., AND FREUND, F.: Treatment of Wounds and Inflammation by X-Rays and Radium Rays. Brit. M. J. **1:** 34–36, Jan. 9, 1944.

Response of the Retina to the Direct Roentgen Beam

A Method of Assessing the Condition of the Retina and an Aid in Localizing Intraocular Foreign Bodies[1]

LT. COMDR. ELLWOOD W. GODFREY, (MC) U.S.N.R., CAPT. HARRY P. SCHENCK, (MC) U.S.N.R., and LT. COMDR. LOUIS E. SILCOX, (MC) U.S.N.R.

THE FOLLOWING report of our experiences with the method described by Pirie (8) and advocated by Pancoast, Pendergrass, and Schaeffer (7), in determining the extent of retinal damage and the presence or absence of radiopaque foreign bodies, is based upon observation of 74 battle casualties with suspected ocular injuries. While in each instance radiography and fluoroscopy were utilized for localization of foreign bodies, this method provided valuable additional information.

In many instances of injury due to combat, ophthalmoscopic observation is impossible because of (*a*) severe edema of the lids and conjunctiva or (*b*) cloudy media. In these patients accurate information concerning the condition of the retina was obtained. This was helpful in planning definitive treatment. When a retinal tear or detachment can be promptly localized, there is a reasonable chance of replacing the retina by operation. Hemorrhage into the vitreous may take weeks for absorption, decreasing the chances of operative success if ophthalmoscopy alone is relied upon.

The principle employed is dependent upon the recognition of a diffuse bluish-green glow by the intact retina when exposed to a direct beam of roentgen rays.

The adequate stimulus for vision is radiant energy of the visible spectrum with a range between 7,500 and 4,000 Å.U. (4) (Fig. 1). The higher figure evidently represents the limit of sensitivity of the retina to the longer wave lengths, for the media of the eye will transmit infra-red rays up to 200,000 Å.U. The lower limit of transmissibility of the shorter waves in the ultraviolet band is about 3,200 Å.U.; this figure applies only if the illumination is intense and the eye completely dark-adapted, and even then, few waves under 4,000 A.U. reach the retina. The cornea absorbs ultraviolet rays below 2,970 Å.U., while the lens transmits only a small portion of those below 4,000 Å.U. That is to say, most of the rays between 4,000 and 2,970 Å.U. are absorbed by either the cor-

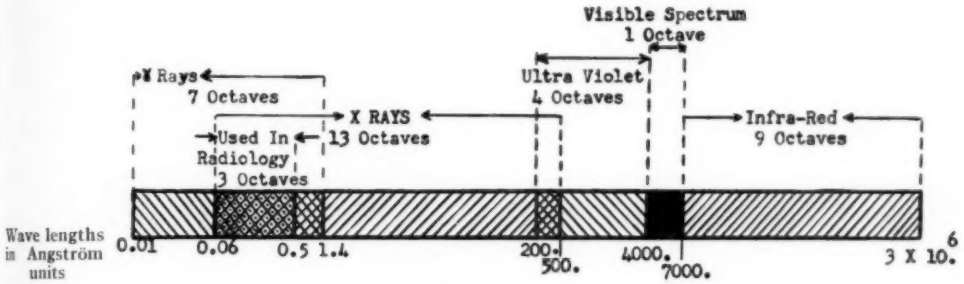

Figure 1.

[1] Thesis submitted (by Lt. Comdr. Godfrey) to the Faculty of the Graduate School of Medicine of the University of Pennsylvania, toward the requirement for the degree of Doctor of Medical Science, D.Sc. (Med.), for graduate work in radiology. From the Radiologic Service. Accepted for publication in May 1944.

The opinions or assertions contained herein are the private ones of the writers, and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large. (Art. 113 (2) U. S. Navy Regulations.)

nea or lens. Wave lengths between 3,500 and 4,000 Å.U. cause fluorescence in the lens (1). Thus the presence of a sufficient quantity of soft x-rays in the heterogeneous beam may have led to the suggestion that the sensation received by the retina is due to fluorescence.

The quantity of light energy necessary to stimulate the retina is not constant for all wave lengths. In the dark-adapted eye, the energy required to cause a just perceptible sensation is least for green light with a wave length of 5,070 Å.U., and has been estimated at 5×10^{-12} ergs per second (1). The threshold value for a heterogeneous beam of x-rays has been calculated at 1/2 r per second to a spot measuring 1 sq. mm. on the retina. This amounts to an absorption of 2×10^{-5} ergs per second in the 50 μ thickness of the rod layer (5).

Dark adaptation curves for light and x-rays are similar (Fig. 2). Even so, Brandes and Dorn (2) were unable to demonstrate any discoloration of visual purple by roentgen rays, in spite of intense and prolonged exposure. Dorn (3) reports no qualitative difference in the light sensation produced on the retinae of the normal and totally color-blind subject.

Proof that both the rods and cones are sensitive to x-rays may be obtained by investigating the retina while interposing a leaded plate with an aperture 1 mm. in diameter between the subject's eye and the anode. This produces the sensation of a circle approximately one-quarter of an inch in diameter at the center of the retina, and of an oval at the periphery. In spite of prolonged searching, the light spot will disappear in one area only. This is presumably the site of entry of the optic nerve. Since the macula lutea containing the fovea centralis is usually no larger than the optic disk, it is evident that the cones are stimulated by the roentgen rays and, since the sensation at the periphery of the globe is as strong as centrally, the rods must also be sensitive, as they exist exclusively in some peripheral areas. That the response is not due to direct stimulation of the optic nerve was evident when

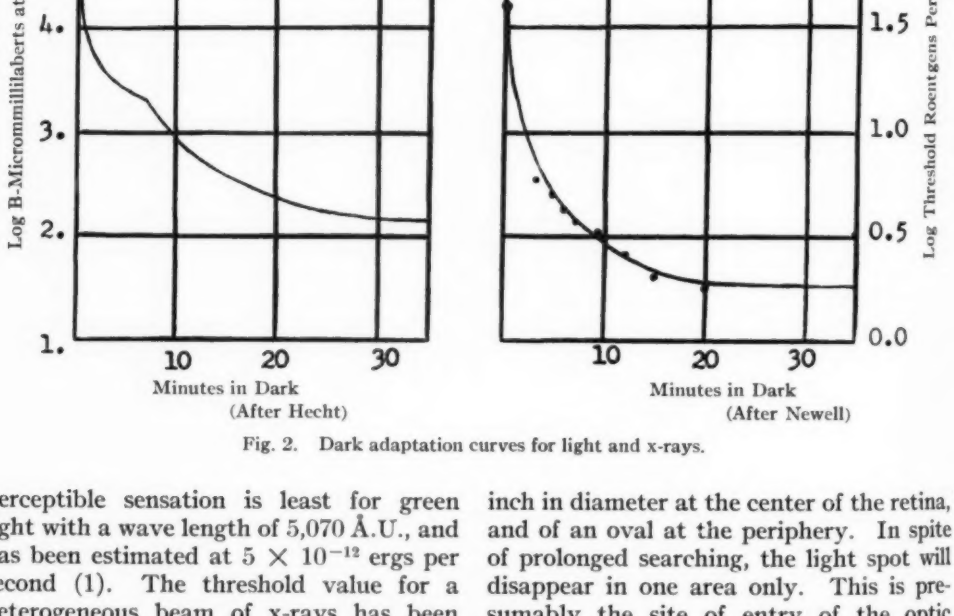

Fig. 2. Dark adaptation curves for light and x-rays.

examination of 6 patients with recent enucleation, and 1 patient with recent evisceration, disclosed an absence of response on the operated side.

Using x-rays, Newell and Borley (5) have had some success in testing visual acuity in eyes with varying grades of diminished vision resulting from opacity of the media. They tested their patients by having them resolve perforations in a stencil subtending a known angle on the retina, and were able to predict fairly accurately the improvement in vision subsequent to such operations as cataract extraction or transplantation for corneal opacity. They suggested that vitamin A may be a factor in the production of the retinal sensation. This has not been established to date.

Technic: The patient is placed in a darkened room for twenty minutes preceding the examination, to increase retinal sensitivity. During this interval the procedure to be undertaken is carefully explained. The subject is positioned facing the x-ray tube so that the field irradiated may be noted on the fluoroscopic screen. The examiner then ascertains the ability of the patient to recognize the retinal response to the roentgen beam with the uninjured eye. To assure comprehension and complete co-operation, the patient is required to describe accurately the effects of irregular and repeated interruptions of the current. When accuracy of observation with the uninjured eye is demonstrated, the beam is shifted to the injured side.

If the involved eye is bandaged, it is well to explain that this has no effect on the examination. Obviously, radiopaque medications, such as compounds of halogens or heavy metals, should not be incorporated in the dressings.

Interpretation: A homogeneous glow with direct irradiation indicates an intact retina. Absence of response may indicate either retinal detachment or a lesion involving the visual pathways. A darkened area in an otherwise homogeneous field usually can be mapped by the patient in the presence of partial detachment, perforation, or tear of the retina. The condition of the globe, anterior to the retina, does not alter this response, since hemorrhage into or clouding of the media due to other causes does not affect appreciably the roentgen beam. Even the recent loss of vitreous fails seriously to impair the retinal response.

With clear media and an intact retina, radiopaque foreign bodies anterior to the retina appear to sparkle, when observed by the patient in the direct beam. The patient describes this scintillation as being very dim and resembling the light from a distant star. If the patient makes this observation, he can localize the particle fairly accurately in the visual field. Obviously, non-radiopaque foreign bodies cannot be ruled out, but at times a foreign body, invisible on the films, may be seen with the ophthalmoscope or described by the patient during this procedure. The sparkling is due to the fact that, upon striking a particle of heavy density, a portion of the energy of the roentgen beam is absorbed and converted, with the result that some visible light is given off. It may be this visible light that enables the retina to detect the foreign body. There should, therefore, be an uninterrupted pathway for light transmission from the foreign body to the retina. Clouding of the media or interposition of the iris absorbs the light emanating from the fragment before it can reach the retina; nevertheless, the condition of the retina may be assessed. The advantage of the latter is apparent in those instances in which direct ophthalmoscopic observation is unsatisfactory because of cloudy media.

Since x-rays are not refracted by the crystalline lens as is ordinary light, the area of the retinal defect, or the image of the foreign body, is reversed only in the higher centers and therefore is diametrically opposite to that described. Thus, if a patient describes a scintillating spot in the right eye at 2 o'clock, its actual location would be at 8 o'clock. The same holds for retinal tears.

TABLE I: CLINICAL FINDINGS IN CASES

Case, Mechanism of Injury, Eye Involved	Visual Acuity	Retinal Response	Foreign Bodies				Fragmentation or Laceration of Globe
			Nature	No.	Size (mm.)	Site	
4. Bomb blast O.D.	Light	Normal	Fe	3	1	Lids, 2 Cornea, 1	.....
5. Shell fire O.D.	20/20	Normal	Al	1	2	Cornea	.....
6. Shell fire O.S.	Light	Normal	Fe	1	4	Sup. obl. muscle	Laceration
8. Machine gun O.S.	15/20	Normal	Fe	3	1	Cornea	.....
9. Machine gun O.D.	Light	Normal	Fe	1	2	Periocular	.....
10. Explosion E motor O.D.	10/20	Normal	Fe	4	1	Periocular	.....
11. Shell fire O.D.	Light	Normal	Powder	Many	..	Cornea	.....
O.S.	Light	Normal	Powder	Many	..	Cornea	.....
12. Land mine O.D.	Light	Normal	.....	None	..	.....	.....
15. Hand grenade O.S.	Light	Normal	Fe	2	1	Periocular	.....
16. Bomb blast O.D.	Light	Normal	Powder	Many	..	Cornea	.....
O.S.	Light	Normal	Powder	Many	..	Cornea and conjunctiva	.....
17. Shell fire O.D.	Light	Normal	Fe	2	2	Anterior chamber, vitreous	.....
23. Welding O.D.	Light	Normal	Flux?	1	..	Cornea	.....
24. Bomb blast O.D.	Light	Normal	Fe-Al	Many	..	Cornea	.....
O.S.	Light	Normal	Fe-Al	Many	2	Cornea and periocular	.....
28. Grenade O.D.	Light	Unsatisfactory	Fe	2	3	Periocular, vitreous	.....
33. Mortar O.D.	11/20	Normal	Al?	4	..	Cornea, 3 Vitreous, 1	Laceration
34. Shell fire O.D.	20/20	Normal	Al?	1?	..	Sclera	.....
40. Bomb blast O.D.	Light	Normal	Fe	1	2	Cornea	.....
46. Bomb blast O.D.	Light	Normal	Fe-Al	2	2	Anterior chamber	.....
47. Machine gun O.D.	4/20	Normal	Glass	2	3	Cornea	.....
48. Grenade O.D.	20/20	Normal	Fe	1	1	Cornea	.....
49. Machine gun O.S.	15/20	Normal	Glass	1	2	Cornea	.....
51. Rifle O.D.	15/20	Normal	Powder	25	..	Cornea and conjunctiva	.....
53. Bomb blast O.S.	Light	Normal	Fe	1	5	Periocular	Laceration
54. Shell fire O.S.	Light	Normal	Fe	1	10	Periocular	Fragmentation
55. Bomb blast O.S.	Light	Normal	.....	None	..	.....	.....
56. Bomb blast O.D.	Light	Normal	.....	None	..	.....	.....
O.S.	Light	Normal	.....	None	..	.....	.....

WITH NORMAL RETINAL RESPONSE

Cornea	Anterior Chamber	Iris	Lens	Vitreous	Retina	Optic Nerve	Case
Ulcer	Clear	Normal	Clear	Clear	Edema	Normal	4
Perforated	Clear	Normal	Clear	Clear	Intact	Normal	5
Perforated	Cloudy	Torn	?	?	?	Normal	6
Ulcers	Clear	Normal	Clear	Clear	Intact	Normal	8
Clear	Clear	Synechia	Opaque	?	?	Normal	9
Ulcer	Clear	Normal	Clear	Clear	Intact	Normal	10
Ulcers	Clear	Normal	Clear	Clear	Intact	Normal	11
Clear	Clear	Normal	Clear	Clear	Intact	Normal	
Hazy; ulcers	Clear	Normal	?	?	?	Normal	12
Clear	Cloudy	Normal	Clear	?	?	Normal	15
Ulcers	Clear	Normal	Clear	Clear	Edema	Normal	16
Scars	Clear	Normal	Clear	Clear	Intact	Normal	
Clear	Clear	Normal	Clear	Cloudy	?	Normal	17
Opaque	Clear	Normal	?	?	?	Normal	23
Ulcers	Clear	Normal	Clear	Clear	Intact	Normal	24
Ulcers	Clear	Normal	Clear	Clear	Intact	Normal	
Perforated	Clear	Normal	Clear	Clear	Intact	Normal	28
Clear	Clear	Normal	Clear	Clear	Intact	Normal	33
Clear	Clear	Normal	Clear	Clear	Intact	Normal	34
Ulcers	Cloudy	Normal	Clear	Hem.	?	Normal	40
Scars	Clear	Normal	Clear	Hem.	Edema	Normal	46
Ulcers	Clear	Normal	Clear	Clear	Intact	Normal	47
Ulcer	Clear	Normal	Clear	Clear	Intact	Normal	48
Ulcer	Clear	Normal	Clear	Clear	Intact	Normal	49
Ulcers	Clear	Normal	Clear	Clear	Intact	Normal	51
Perforated	Clear	Normal	Clear	Clear	Edema	Normal	53
Hazy	Lost	Torn	Dislocated	Escaped	?	Normal	54
Clear	Hem.	Irregular	Clear	?	?	Normal	55
Clear	Clear	Normal	Clear	Clear	Edema	Normal	56
Clear	Clear	Normal	Clear	Clear	Edema	Normal	

TABLE II: CLINICAL FINDINGS IN CASES

Case, Mechanism of Injury, Eye Involved	Visual Acuity	Retinal Response	Foreign Bodies				Fragmentation or Laceration of Globe
			Nature	No.	Size (mm.)	Site	
1. Shell fire O.D.	0	Normal scint.	Fe	10–12	1	Cornea, 3 Vitreous, 6–8	Laceration
2. Shell fire O.D.	0	Absent	Fe-Al	2	45-15-2	Vitreous	Laceration
3. Mortar O.S.	0	Absent	Fe	1	15-5-2	Vitreous	Laceration
7. Bomb blast O.S.	Light	Retinal tear	Fe	3	1	Upper lid	.....
12. Land mine O.S.	0	Absent	.....	None	....	.....	Fragmentation
13. Shell fire O.S.	0	Absent	Fe	1	10-5-2	Periocular	Fragmentation
14. Shell fire O.D.	0	Absent	.....	None	....	.....	Fragmentation
18. Shell fire O.S.	0	Absent	Fe	1	8-6-2	Vitreous	Laceration
19. Shell fire O.S.	0	Absent	Debris	Many	Minute	Anterior chamber	Laceration
20. Shell fire O.S.	0	Absent	Fe	1	7-5-5	Sphenoid sinus	Laceration
21. Shell fire O.S.	0	Absent	Fe	1	30-15-7	Globe	Fragmentation
25. Shell fire O.D.	0	Absent	Fe	2	3-5-2	Periocular	Fragmentation
26 Shell fire O.D.	Light	Normal scint.	Fe	15–18	3-2-2	Cornea, lens, vitreous	Laceration
27. 40-mm. shell O.S.	0	Absent	Fe	5	10-5-5	Periocular	Fragmentation
29. Shrapnel O.S.	0	Absent	Fe	7	1	Lens	Laceration
30. Shell fire O.S.	0	Absent	Fe	1	15-15-3	Vitreous	Laceration
31. Torpedo O.S.	0	Absent	Fe	8	1	Globe	Fragmentation
32. Shell fire O.S.	0	Absent	Al	1	2-2-1	Vitreous	Laceration
35. Mortar O.S.	0	Absent	Fe	3	1	Cornea	Fragmentation
36. Pom-pom 1.1 O.S.	0	Absent	Fe	1	5-3-1	Periocular	Laceration
37. Mortar O.S.	0	Absent	Fe	Many	1	Globe	Fragmentation
39. Shell fire O.D.	0	Absent	Brass	Many	7-5-2	Periocular	Laceration
41. Bomb O.S.	0	Absent	Debris Al	Many	....	.....	Laceration
42. Machine gun O.S.	0	Absent	Fe, Brass	10	1	Globe	Laceration
O.D.	Light	Absent	Fe, Brass	15	1	Cornea	Laceration
43. Rifle O.S.	Light	Normal scint.	Pb	4	1	Cornea, 2 Vitreous, 2	Laceration
52. Grenade O.S.	Light	Retinal tears	Fe	25–30	1	Cornea, 18 Ant. cham., 1 Iris, 2	Laceration

The depth of penetration of a foreign body $\sim \frac{\text{mass} \times \text{speed}^2}{\text{frontal area}}$. Mass $\sim$ volume $\times$ density, and frontal area $\sim$ volume $^{2}/_{3}$ (6). It can be reasoned, therefore, that larger foreign bodies will tend to penetrate deeper than smaller ones. In general, this was true in the cases that we observed. If the

WITH ALTERED RETINAL RESPONSE

Cornea	Anterior Chamber	Iris	Lens	Vitreous	Retina	Optic Nerve	Case
Perforated	Clear	Hem. 4 o'clock	Clear	Hem.	Intact	Normal	1
Opaque	Cloudy	?	?	Lost	?	?	2
Clear	Hem.	?	?	Cloudy	?	?	3
Clear	Clear	Normal	Clear	Clear	Partial detachment	Normal	7
Opaque	Lost	Lost	Dislocated	Lost	Destroyed	?	12
Lost	Lost	Lost	Lost	Lost	Destroyed	?	13
Lost	Lost	Lost	Dislocated	Lost	?	?	14
Perforated	Clear	Protruding	Opaque	Hem.	?	?	18
Torn	Debris	Prolapsed	?	?	?	?	19
Perforated	Lost	Torn	Dislocated	Lost	Destroyed	?	20
Clear	Hem.	Torn	Dislocated	Lost	Destroyed	Severed	21
Opaque	?	Lost	Lost	Lost	?	Severed	25
Perforated	Lost	Torn	Dislocated	Clear	Intact	Intact	26
Perforated	Cloudy	Irregular	Clear	Hem.	?	?	27
Perforated	Clear	Torn	Opaque	?	?	?	29
Clear	Clear	Normal	Clear	Lost	Torn	Severed	30
Perforated	Lost	Torn	Dislocated	Lost	?	?	31
Perforated	Lost	Torn	Dislocated	Lost	?	?	32
Opaque	Lost	Torn	Dislocated	Lost	?	?	35
Clear	Clear	Normal	Clear	Clear	Detached	?	36
Lost	Lost	Lost	Lost	Lost	?	?	37
Perforated	Cloudy	Torn	Dislocated	?	?	?	39
Clear	Hem.	?	?	?	?	?	41
Perforated Perforated	Clear Clear	Normal Coloboma	Dislocated Clear	Hem. Hem.	? Intact	? Normal	42
Perforated	Clear	Torn	Clear	Clear	Intact	Normal	43
Clear	Clear	Normal	Hazy	Hem.	Partial detachment	Normal	52

foreign body penetrated to the vitreous, its size usually was such as to produce sufficient visible light under bombardment for it to be detected by the patient. Likewise, a foreign body possessing sufficient mass and velocity to perforate the retina should produce an observable defect.

In some instances, the patients were able

to estimate the number of foreign bodies present. Thus, one patient (Case 1) could detect 6 to 8 scintillating spots which were interpreted as foreign bodies. Another (Case 52) was able to outline two areas representing retinal tears.

DISCUSSION

Of the 74 patients examined with direct irradiation, 41 were interpreted as having a normal response bilaterally; 33 described either an altered response, scintillation, or complete absence of visual stimulus in one or both eyes. Fifteen of the patients with a normal retinal response bilaterally are not included in the tables, as in these cases there was no direct ocular damage; 7 patients with operative removal of damaged globes prior to admission are also omitted. Of the remaining cases, those with a normal retinal response are briefly described in Table I, while the condensed clinical findings on those showing a variation from the normal are presented in Table II.

In 10 patients injury was due either to blast or the combination of blast with metallic foreign bodies (Cases 4, 7, 16, 24, 40, 46, 52, 53, 55, and 56). In two (Cases 7 and 52), retinal tears were present. Both patients mapped the torn areas on exposure to direct roentgen rays. In neither did metallic fragments penetrate to the vitreous, and we feel that the retinal tears were due to transmitted pressure. Confirmation of the tears was obtained by direct ophthalmoscopic findings.

The remaining 8 described a normal retinal response. By ophthalmoscopy the retina appeared normal in 1. Hemorrhage into the vitreous prevented direct observation in another. Petechial hemorrhages and edema of the retina were seen in 6, and it is to be noted that in the absence of permanent retinal damage, the retinal responses were normal.

Three patients described scintillating spots on direct roentgenoscopy (Cases 1, 26, and 43). All three had foreign bodies in the vitreous. In one patient (Case 43) these were removed operatively. Another (Case 1) had multiple small metallic splinters that were so numerous and of such a size as to contraindicate operative intervention. The third patient (Case 26) subsequently required an evisceration because of extensive ocular damage and associated infection.

As previously pointed out, we were able to predict an intact retina in 9 patients in whom ophthalmoscopic observation was impossible because of hemorrhage into or clouding of the media; while in 15 instances in which ophthalmoscopy was impossible, retinal destruction was predicted.

There was one instance of which we are aware in which the condition of the retina was not properly assessed. Though the retinal response was reported absent bilaterally (Case 42), the patient subsequently had light perception in his right eye.

CONCLUSIONS

1. The sensitivity of the retina to x-rays is discussed.

2. This method, in its present development, is of value in limited cases and as an adjuvant to the tests employed by ophthalmologists, in assessing the condition of the retina.

3. Occasionally intraocular foreign bodies may be detected by the subject or observed with the ophthalmoscope when the x-ray beam traverses the globe to reach the intact retina.

U. S. Naval Hospital
Quantico, Va.

BIBLIOGRAPHY

1. BEST, C. H., AND TAYLOR, N. B.: Physiological Basis of Medical Practice. Baltimore, Williams & Wilkins Co., 3d ed., 1943.

2. BRANDES, E., AND DORN, E.: Über die Sichtbarkeit der Röntgenstrahlen. Ann. d. Physik **60:** 478–490, 1898.

3. DORN, E.: Über die Sichtbarkeit der Röntgenstrahlen für vollständig Farbenblinde. Ann. d. Physik **66:** 1171–1176, 1898.

4. DUKE-ELDER, W. S.: Text-Book of Ophthalmology. St. Louis, C. V. Mosby Co., 1932.

5. NEWELL, R. R., AND BORLEY, W. E.: Roentgen Measurement of Visual Acuity in Cataractous Eyes. Radiology **37:** 54–61, 1941.

6. NEWELL, R. R.: Personal communication.

7. PANCOAST, H. K., PENDERGRASS, E. P., AND SCHAEFFER, J. P.: The Head and Neck in Roentgen Diagnosis. Springfield, Ill., Charles C Thomas, 1940.

8. PIRIE, A. H.: Reading with Closed Eyes. Canad. M. A. J. **27:** 488–490, 1932.

Traumatic Pneumocephalus[1]

L. H. GARLAND, M.D., and M. E. MOTTRAM, M.D.
San Francisco, Calif.

PNEUMOCEPHALUS or intracranial pneumatocele is sometimes encountered after fractures involving the sinuses and mastoids. Occasionally it occurs as a result of infection with gas-producing organisms or as a result of an intracranial tumor eroding into the sinuses. Most of the reported cases followed fractures. The mechanism of production after fracture involves a break in the wall of the skull, through which air can be forced either by increased external pressure or by a ball-valve action of a piece of tissue or bone. With compound fractures not involving the sinuses or middle ear, there is no simple mechanism whereby increase in the external pressure can initiate intracranial air collections. With coughing, sneezing, swallowing, and blowing the nose, the pressure in the sinuses and mastoids is momentarily increased and when fractures occur through these regions air may be forced through the fracture site into the cranial cavity.

TYPES

Pneumocephalus may be either extracranial or intracranial. Extracranial collections of air occur in the subaponeurotic space of the scalp. They follow a break in the outer wall of the frontal sinuses or mastoid air cells. With increased pressure, air can be forced out to form swelling in the loose tissues.

Intracranial collections are the more common type, the air being located in the subarachnoid space, the subdural space, the brain, or the ventricles.

Air in the subarachnoid space usually arises from fractures in the posterior ethmoidal and sphenoidal cells and is often accompanied by a meningitis. Subdural air usually follows fractures through the posterior walls of the frontal sinuses, as there is a large potential space in the frontal region. This type may be unilateral.

Intracerebral collections are one of the more common types and may be associated with subdural air. The air may be in the brain substance or ventricular system. Air may be demonstrated in either the subarachnoid or ventricular spaces or both, depending on the extent of adhesions, the location of the fracture, and the amount of external pressure.

DELAYED DEVELOPMENT

In a number of the reported cases, and in the case to be recorded here, the pneumocephalus *developed after a latent period* of several days up to several months. In Dandy's series of cases reported in 1926, only 6 of 24 traumatic cases for which the time interval was stated showed the pneumocephalus before one week; in 3 more it was evident before a month. In 10 it developed during the fourth to sixth weeks and in 5 at later dates, specifically 2 at two months and 1 each at three months, seven months, and ten months. The usual interval before recognition is about one month. The reason for this latent period has not been determined. It is our impression that the immediate surrounding hemorrhage and edema may be a factor in preventing the passage of air into the subdural region. Also, during the first few weeks the patient is usually at bed rest. After a latent period during which the edema regresses and healing progresses, the patient becomes more active and it is at this time, three to four weeks after injury, that the air becomes manifest in a number of cases.

The factor which precedes the recrudescence of symptoms is often blowing the nose, sneezing, or unusual activity. The patient may report that there is a flow of clear fluid from the nose following blowing or sneezing. This is a pathognomonic sign of skull fracture involving the sinuses and is present in a large number of cases of pneumocephalus.

[1] Accepted for publication in April 1944.

Fig. 1. Roentgenograms made Oct. 6, 1943, about four weeks after injury, showing metallic fragments and stellate fractures. No intracranial air is shown.

SYMPTOMS AND PROGNOSIS

The symptoms at this time may be extremely mild, as pneumocephalus is occasionally found only incidental to examination and may be overlooked if x-ray studies are not made. Usually, however, there is a varying degree of central nervous system irritation, often associated with a meningismus or signs of increased intracranial pressure. Headache then develops, associated with vomiting, drowsiness, diplopia, dizziness, and often rhinorrhea. With further increased intracranial pressure, there occur delirium and coma. The differential diagnosis following this sequence must take into consideration brain abscess, subdural hemorrhage, and meningitis. Without roentgen study, pneumocephalus may be incorrectly diagnosed as one of these three conditions, because they are more common.

The mortality is around 40 per cent. Death is usually due to meningitis. Surgical exploration, with closure of the dural wound, may be necessary. The duration of the intracranial air shadows is related to the amount of air which is forced through the opening and the length of time the opening is patent.

In 1926, Dandy reviewed a group of cases collected from the literature and added 3 of his own. Of these, 25 were traumatic, 1 followed erosion of the sinus wall from chronic infection, 1 followed erosion of the floor of the skull by a tumor, and 1 showed air in an abscess cavity and ventricle three days after mastoid surgery. Since that time a number of cases have been recorded, usually as single case reports. In 1934, Smith and Malcolmson collected 43 cases and added 2 of their own. It is probable that this condition will be of more frequent occurrence with the increased number of skull injuries in the present war.

The case we are reporting (with sponta-

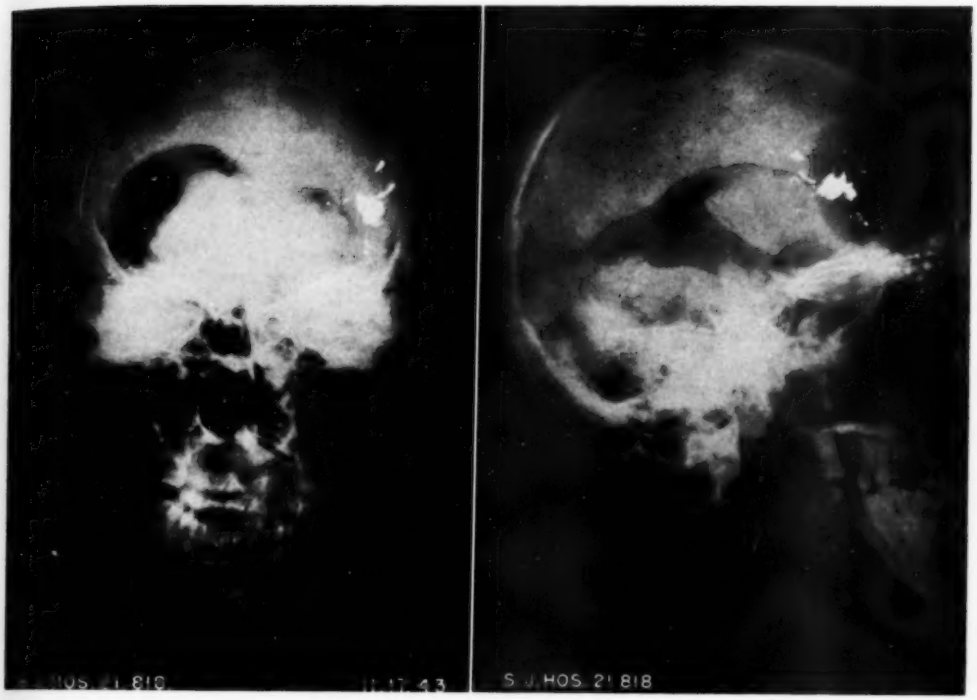

Fig. 2. Roentgenograms made Nov. 17, 1943, nine weeks after injury, showing air in the ventricles, and subdural air in the right frontal region.

neous recovery) presents the "typical" course, if such can be said to occur. After a latent period of nine weeks, the pneumocephalus developed, with an associated rhinorrhea and a recurrence of cerebral symptoms. After a further interval of two weeks the patient recovered.

CASE REPORT

On Sept. 10, 1943, the patient, a white male, aged 28, attempted suicide by shooting himself in the right temporal region. There was loss of vision in the right eye, but no other neurological symptoms were observed. The local wound healed by primary intention. The general condition was satisfactory, and three weeks after the injury the patient was dismissed from another hospital with no symptoms except blindness in the right eye. Films at this time showed fractures as described below, and no pneumocephalus.

The patient then entered St. Joseph's Hospital for study in connection with his amaurosis. His general condition was good. There were ecchymosis and edema of the right temporal region with marked hyperesthesia over this area, so that the patient was unable to shave. The right conjunctiva was chemotic. There was no reaction of the right pupil to light or accommodation, and no light perception. The lower half of the right retina was detached. There were no other subjective or objective findings.

X-ray examination on Oct. 6, 1943, revealed multiple metallic fragments scattered through the frontal lobe along the path of the bullet, with several large fragments under the inner table in the left frontal region. The point of entrance of the bullet was in the right temporal area with a resultant large stellate fracture, showing extension through the floor of the anterior fossa and across the frontal and ethmoidal sinuses. There was a second, smaller, stellate fracture in the left frontal area. No intracranial air was demonstrated (Fig. 1).

The patient was dismissed from the hospital after a few days, and there was no essential change in his condition for several weeks. On Nov. 16, 1943, nine weeks after his injury, he had two severe bouts of headache associated with vomiting. He states that he blew his nose and recovered "a large amount of vomitus." No additional physical findings were demonstrated at this time except for the drainage of watery fluid from the nose for four days —presumably spinal fluid.

X-ray examination showed a large amount of air in both lateral ventricles and some in the third and fourth ventricles. The right lateral ventricle was

as well filled as if pneumography had been performed. There was also a large collection of subdural air in the right frontal area in the region of the fracture through the anterior fossa (Fig. 2).

The patient was placed at bed rest, became comfortable and had no further headaches or vomiting. Skull films ten days after entry showed only a trace of air remaining in the lateral ventricles and no subdural air. There have been no further complaints since discharge, and the patient has returned to work.

SUMMARY

A case of traumatic pneumocephalus is reported. It followed a penetrating skull injury associated with fractures through the frontal and ethmoidal sinuses. The methods by which the intracranial air may develop and explanations for the period of delay in the appearance thereof are outlined. The case reported showed spontaneous "cure."

450 Sutter Street
San Francisco, Calif.

BIBLIOGRAPHY

1. BARDEN, R. P.: Traumatic Pneumocranium. Am. J. Roentgenol. **43:** 514–516, April 1940.
2. CAMPBELL, E. H., AND GOTTSCHALK, R. B.: Osteoma of the Frontal Sinus and Penetration of Lateral Ventricle, with Intermittent Pneumocephalus. J. A. M. A. **111:** 239–241, July 16, 1938.
3. DANDY, W. E.: Pneumocephalus. Arch. Surg. **12:** 949–982, May 1926.
4. FLOWER, C. F.: Pneumocephalus: Case Report. U. S. Nav. M. Bull. **39:** 553–555, October 1941.
5. LEWIS, A. J.: Traumatic Pneumocephalus. Brain **51:** 221–243, June 1928.
6. MILLER, S. W., KLEMMER, R. N., AND SNOKE, P. O.: Traumatic Pneumocephalus. J. A. M. A. **96:** 172–173, Jan. 17, 1931.
7. PRINGLE, J. H.: Two Cases of Pneumocranium. Lancet **2:** 724–726, Sept. 24, 1938.
8. RAND, C. W.: Traumatic Pneumocephalus. Arch. Surg. **20:** 935–958, June 1930.
9. SMITH, J. S., AND MALCOLMSON, P. H.: Traumatic Pneumocephalus. Canad. M. A. J. **30:** 650–651, June 1934.
10. STUCK, R. M., AND WEATHERBY, F. E.: Pneumocephalus. Arch. Neurol. & Psychiat. **44:** 1093–1097, November 1940.
11. TAFT, R.: An Unusual Case of Traumatic Pneumocephalus. Am. J. Roentgenol. **25:** 800–801, June 1931.
12. THOMPSON, C. F., AND REED, J. V.: Traumatic Pneumocephalus. J. A. M. A. **98:** 981–983, March 19, 1932.

Response of the Liver to Irradiation[1]

FRIEDRICH ELLINGER, M.D.

Research Associate in Radiology, Long Island College of Medicine, Brooklyn, N. Y.

ADVANCES in radiological engineering as well as in therapeutic administration —*i.e.*, fractionation and protraction of doses—have enabled the radiologist to deliver increasingly larger amounts of radiation to the organs of the body. While in former decades the response of the skin was the chief concern of the radiologist, more recently the response of the bodily organs has attracted increasing interest.

Perhaps in no field of radiation biology are opinions so greatly divergent as in assessing the response of the liver to irradiation. On the basis of clinical experience, Pack and Livingston (97) classify the liver among the most radiosensitive structures. Jüngling (70), on the other hand, considers the liver relatively radioresistant, and Wintz (126) writes: "According to my experience the radiosensitivity of liver tissue is not very great. It is less than that of the skin and mucous membranes. One may safely expose the liver to a single dose as high as 150 per cent S.E.D. without noticing clinical symptoms indicative of decomposition of liver cells." Desjardins (27) places the liver between skin and muscle in radiosensitivity.

Clinical evidence is available in support of both high and low radiosensitivity of liver tissue. Favoring high radiosensitivity are observations by Beutel (9), Bromeis (15), and Germer and Mellemgaard (52) on increased excretion of urobilin after extensive fluoroscopy during gastro-intestinal examinations. Since experimental studies have revealed the fact that increased urobilinuria is one of the earliest signs of liver damage (Elman and McMaster, 44) and recent observations by Bell (7) have shown that considerable doses of x-rays are delivered to the patient's body during gastro-intestinal fluoroscopy, these clinical observations seem to be highly significant. On the other hand, the very few reports in the literature indicating serious injury of the liver in patients exposed to extensive x-ray treatment (Mosse, 94; Wetzel, 124; Case and Warthin, 19; Warthin, 121; Palmer and Templeton, 98) seem to support the assumption that the liver can tolerate a considerable amount of radiation without significant damage. It must be taken into consideration, also, that in the reported cases of extensive liver changes following irradiation the organ was already impaired by the basic disease for which radiological treatment was given. It is true that Hall and Whipple (58) in their experiments have not been able to demonstrate an additive effect of chloroform anesthesia and lethal and sublethal doses of x-rays in dogs, but from general pathological observations such an additive effect may safely be assumed. Finally, the well known fact that radiation sickness is more frequent in patients suffering from functional disturbance of the liver (Neuda, 96) supports this point of view.

Since clinical data do not permit a definite opinion concerning the response of the liver to irradiation, an attempt will be made to analyze the results of animal experiments. This analysis will consider the morphologic changes, the histochemical changes, the chemical changes, and the functional changes occurring in the liver after irradiation. On the basis of these data, a quantitative analysis will be attempted. Finally, the mechanism producing these effects will be briefly discussed.

QUALITATIVE EFFECTS OF IRRADIATION ON THE LIVER

1. Morphologic Changes

In a recent review of the "Effects of Radiation on Normal Tissues," by Warren

[1] Aided by a grant from Wm. R. Warner & Co., New York, N. Y. Accepted for publication in June 1944.

and his associates (119), the statement is made that "the effects of radiation on the liver should be of unusual interest inasmuch as there are two highly specialized kinds of epithelium besides an important endothelial system and vascular and fibrous elements to compare." Accordingly, the changes in the various tissues of the liver should be considered separately. The difficulties to be encountered in studies along this line are enumerated in Warren's review, and species specificity is mentioned as a major obstacle, as well as the extensive regenerative power of liver tissue and the diversity of irradiation procedures.

Because of Warren's review, the present discussion of morphologic changes may be shortened.[2] As he has pointed out, some investigations (14, 64, 73, 107, 120) have been recorded in which no changes were observed in the liver. These observations belong to the early period of experimental radiology. The negative results are easily explained as due to insufficient irradiation or too short an observation time. Brief mention should be made of the paper by Hall and Whipple (58). These authors stated that they did not find any changes in the parenchymatous organs. Their report cannot, however, be accepted without reservation, since a closer study of their autopsy reports, as pointed out by Case and Warthin (19), reveals some changes in the livers of two dogs.

Changes in the *parenchyma of the liver* have been observed in man (19, 94, 98, 121, 124) and in the following animal species: dogs (3, 12, 29, 50, 58, 91), rabbits (65, 74, 104, 116, 117, 123), cats (50, 65, 104), guinea-pigs (48, 67, 113, 114), rats (21, 82, 100), mice (20, 75, 78, 90), and frogs (115, 118). Hyperemia, hemorrhages, and sometimes necrosis have been the principal observations. "Repair is almost coincident with injury and proceeds along normal lines" (Warren).[3]

An original procedure has been used by Casati and Cafissi (18) to study the influence of radiation on the liver cells without interference by repair. They exposed livers of freshly killed animals to doses of x-rays of 1,000–2,000 r (100 r per minute) and observed very severe protoplasmic changes. Since "the cell is the site of action of all radiation upon animal human tissues" (39), the effects on the morphology of liver cells merits a more detailed description.

Krause and Ziegler (75) mentioned poorer staining of some parts of the livers of mice exposed to radiation. An excellent description of the cellular changes has been given by Mills (90). Following the application of radium over the anterior abdominal wall in mice, "the earliest definite change noticed occurred about one hour after irradiation. The liver cells . . . were more granular than usual and there were none of the clear glycogen-containing vacuoles which are present in the normal mouse liver." Three hours after exposure, "the protoplasm was deeply granular and the nucleus stained very clearly and was considerably swollen. The latter averaged in diameter fully one-half that of the liver cell, whereas in the normal condition it averages one-fourth to one-third. The whole cell also was slightly increased in size, but not nearly to such an extent as the nucleus." After six hours, "the cells appear more normal. Protoplasm was no longer granular, but the nucleus was still enlarged." After twenty-four hours, "the vast majority of the liver cells appeared normal. There were, however, scattered . . . a few cells which appeared to have degenerated completely." While the liver appeared normal on the third day after irradiation, further changes in liver cells were observed about two weeks after exposure. These cyclic changes in the liver cells after

[2] Consideration of the effects of injected and deposited radioactive substances has been omitted from our review because of the difficulty of estimating to what extent the material deposited in the liver acts as a foreign body and thereby contributes to the histologic changes observed. Pertinent data will be found in the review by Warren (119).

[3] Details concerning the repair process will be found in the papers by Bolliger and Inglis (12), Kolodny (74), Mills (90), Pohle and Bunting (100), and Tsuzuki (117).

irradiation have also been noticed by Pohle and Bunting (100) and by Fischel (48) in rats.

Contrary to the belief of the earlier writers that the first manifestation of liver cell injury is to be found in the nucleus, these investigations point to the cytoplasm as the site of the earliest cell changes. The results of specialized investigations concerning the mitochondria are in agreement with these conclusions drawn from general studies of the cytological changes. Variations in these cytoplasmic structures have been observed in rabbits (93), guinea-pigs (61), and frogs (69, 115, 118). Studies of the mitochondria of frog liver cells have been especially revealing. Wail and Frenkel (118) irradiated frogs with doses ranging from 1/8 to 1 1/2 S.E.D. (factors: 180 kv., 4 ma., 0.5 mm. Cu and 1.0 mm. Al filtration). Four to eight hours after exposure, the rod-shaped mitochondria appeared cigar-shaped and finally changed into granula. The rapidity of these changes was found to increase with increasing doses. Thus, in liver cells morphologic changes in the cytoplasm may precede those in the nucleus.

Changes in the *stroma of the liver* concern chiefly the blood vessels. A detailed description has been given in Warren's review (119).

Reticulo-endothelial changes are described in the Kupffer cells. The majority of the reports mentioning Kupffer cells at all do so in connection with their vital staining, which has at times been found to be increased and at other times decreased (8, 17, 22, 23, 26, 57, 65, 55, 74, 105). Since, however, intravital staining of liver cells seems, in the light of recent investigations, to be an expression of functional changes, a more detailed discussion will be given later in considering liver function (p. 244).

Tang (111) observed rarefaction of Kupffer cells in the liver of a rabbit which died on the tenth day after exposure to 500 r from a 7-gm. radium pack. Degeneration of Kupffer cells has been observed in rats by Schwienhorst (106). Windholz (125) described vacuolation of Kupffer cells in guinea-pigs on the third day after total body irradiation with 600 r (factors: 180 kv., 0.5 mm. Zn filtration). It is noteworthy that at the same time the spleen also exhibited severe changes in the form of a considerable decrease in the number of follicles. Hyperplasia of Kupffer cells has been described by Calò (17) and Callierio (16) in mice, and by Tsuzuki (117) in rabbits.

Changes in the *bile ducts of the liver* have been recorded not only in man (Case and Warthin, 19) but also in various experimental animals. We are in agreement with Friedman (see Warren, 119), that "the type of proliferation of biliary epithelium described fairly frequently in connection with radiation change in the liver suggests a repair reaction . . . rather than one initiated by injury of ducts *per se*."

2. *Histochemical Changes*

Decrease in glycogen (2, 48, 61, 65, 99, 116, 117) and *increase in sudanophil fat content* (4, 12, 21, 29, 61, 80, 81, 86, 93, 100, 104, 111) following irradiation have been described for all animal species. While the changes in the glycogen content manifest themselves soon after exposure, the changes in the fat content usually appear at a later date.

3. *Chemical Changes*

The importance of the histochemical studies is supported by the quantitative chemical analysis of liver tissue from irradiated animals. Rother (103) irradiated guinea-pigs over the liver with 1 S.E.D. (factors: 180 kv., 2 ma., no filter), which was an absolute lethal dose. He found the *glycogen content* of the liver tissue decreased while the blood sugar level remained high. Of great importance is his observation that the perfused livers of irradiated animals did not release sugar. This points to the fact that the release of sugar is a secondary process. It was shown by Rother to depend on the integrity of the autonomic nervous system.

As far as fat is concerned, the investigations deal exclusively with the *content of*

TABLE I: CHANGES IN BLOOD AND LIVER CHOLESTEROL IN MICE AFTER IRRADIATION (LÖW-BEER)

Interval after Exposure	300 r		600 r		1,000 r	
	Blood	Liver	Blood	Liver	Blood	Liver
2 hours	−6.9%	−53 %	..	..	..	..
4 hours	−23 %	− 2.9%	−67%	+ 6%	−19%	− 9%
24 hours	−60 %	+28 %	−43%	+11%	−45%	+38%
48 hours	....	....	..	..	−49%	+38%
5 days	....	....	..	..	−24%	+55%
8 days	+ 3 %	+ 3.5%	−37%	+89%	..	..

cholesterol, which has been found to be increased in rats (46) and mice (84). Of considerable interest are the careful studies made by Löw-Beer (84), who exposed mice to a dose of 300 to 1,000 r (factors: 180 kv., 4 ma.) and compared the cholesterol levels in blood and liver. The figures in Table I are taken from his paper and express the percentage of change in cholesterol based on pre-irradiation levels. These figures not only are interesting, because they confirm fully histochemical studies as to quantitative results and their dependence on the time of observation, but they also seem to throw some light on the origin of the fat which was observed at certain times in irradiated livers.

As an expression of effects on the proteins of liver tissues, *increase in non-protein nitrogen* and *decrease in amino-acids* have been observed in rats and guinea-pigs (62, 63).

Other tissue constituents of which a quantitative analysis has been made are *chlorides*, which have been found to decrease. Beutel and Winter (10) gave doses of 750 to 1,000 r (total body irradiation) to rats (factors: 180 kv., 4 ma., 0.5 mm. Cu and 1.0 mm. Al filter, 40 cm. distance). These animals, whether examined on the first, second, third, fifth, or eighth day after exposure, always showed a decrease in chlorides. Nor did the mode of treatment —whether radiation were given in one session or in divided doses—change the result. From these investigations it would appear that the liver is the only organ which reacts to irradiation with a constant loss of chlorides.

After total body irradiation of rats with 100 to 200 per cent S.E.D. (factors: 170 kv., 0.5 mm. Cu and 2.0 mm. Al filter) increase in oxidized as well as in reduced *glutathione* has been found. No increase was induced by irradiation of livers *in vitro* (Nathanson and Tscherkes, 95).

No significant changes in the *vitamin A* content of guinea-pig livers has been observed (112) within twenty-four hours after local application of 550 r (field 6 × 8 cm., filtration 0.5 mm. Cu and 1.0 mm. Al). Nor was the vitamin A content of human livers influenced by irradiation *in vitro* (102). Decrease in *vitamin C* content occurred in the livers of irradiated rats (59).

Irradiation of rat liver *in vitro* led to a decrease in *phosphatase* (87).

4. *Functional Changes*

From the data reported, it is evident that far-reaching functional changes must take place in the cells of livers of irradiated animals. Experiments with intravital staining especially point to changes in cell permeability. In agreement with these findings are the studies of Mendeléeff (89) on the *electrical cell potential of liver cells* of guinea-pigs. Animals irradiated over the abdomen for ten minutes (factors: 180 kv., 4.0 ma., 0.5 mm. Cu and 1.0 mm. Al filtration, distance 23 cm.) showed no immediate change in electrical cell potential as compared with unirradiated controls. Animals killed nineteen to twenty-four hours following exposure showed a decreased cell potential, but four to five days after exposure no difference between the potentials of liver cells in irradiated and unirradiated guinea-pigs was observed. These findings do not necessarily signify

a functional reaction in a cell, since we were able to demonstrate a similar breakdown of the electrical cell potential and its restoration within a period of days in a non-living model of a cell (collodion membranes) after irradiation (33).

The significance of vital staining has been discussed in detail by Halberstaedter and Wolfsberg (57). Recent studies by Laurens and Graham (77) and Graham (55) have demonstrated that the *increased vital staining capacity of livers* in irradiated dogs can be reversed by the administration of adrenocortical preparations. These observations definitely classify this phenomenon under the heading of vital functions rather than morphologic changes.

As an expression of disturbed cell function Heeren and Pansdorf (63) noticed a *decrease in the oxygen consumption* of irradiated livers from 22.7 c.mm./mg./hr. to 13.1 c.mm./mg./hr. in mice irradiated with 550 r in air over the abdomen. Total body irradiation of rats with 1,500 r (factors: 120 kv., 4 ma., 4 mm. Al filtration) *increased the anaerobic glycolysis* (Druckrey *et al.*, 30). This change in aerobic glycolysis indicates that the metabolism of the irradiated liver cell is similar to that of malignant tumor cells and of various other irradiated tissues (39).

There is *increased enzymatic activity* in the livers of irradiated animals (Abderhalden, 1). Most important is the increased postmortem autolysis (120).

Gross studies to prove disturbance of liver function following irradiation have repeatedly been made and the results are in part negative (Borak and Kriser, 13) and in part positive (Czepa and Högler, 24). Disturbance of liver function has also frequently been inferred from studies of blood levels of various substances. Since these changes do not depend exclusively on liver function proper and may be subject to extrahepatic radiation effects, their discussion will be omitted.

Detail studies of liver function following irradiation have been reported by various investigators. Thiele and Hartkopf (112) observed *disturbance of the storage capacity of the liver for vitamin A* in guinea-pigs. Furthermore, *disturbances in bile secretion* have been seen. Increased secretion in dogs with bile fistulae has been reported by v. Barbaczy (6). Takeda and Youen (110) observed an increased secretion of bile following small doses of radiation and a decreased flow after larger doses. Inhibition of bile secretion by large doses of radiation was also observed by Smyth and Whipple (108) in dogs. Similar changes have been demonstrated in frogs by intravital microscopy (Hartoch and Israelski, 60).

5. *Summary*

In summarizing the qualitative effects produced in the liver by irradiation of animals, we can establish the following facts:

1. Basically the same effects have been found to occur in all animal species investigated.
2. The observation of these effects depends on:
   (*a*) The dose of irradiation: The material presented shows that there exist definite threshold doses for the various cytologic, histochemical, and functional changes.
   (*b*) The time of observation: It is evident from the material presented that irradiation produces a chain of reactions in liver tissues. It is, therefore, easy to understand how some authors failed to observe certain phenomena usually forming the last links in this chain, when their observations were made shortly after exposure.
   (*c*) The methods of observation: By the use of the most refined and sensitive methods, some effects have been noted immediately after cessation of irradiation. Other procedures have failed to disclose such changes, and some of the apparently contradictory results may be explained on this basis.

3. Roentgen-rays may be classified with the hepato-toxic agents, producing effects similar to those of phosphorus ingestion. This statement is based on the histologic changes, *i. e.*, accumulation of sudanophil fat in the central parts of the liver lobules, accompanied by cloudy swelling, which is considered as "fatty degeneration" (Karsner, 71). Also, the metabolic changes are similar to those usually found in phosphorus poisoning (Sollmann, 109).

QUANTITATIVE EFFECTS OF IRRADIATION ON THE LIVER

1. Approach to the Problem

The great variety of procedures used for the experimental study of the effects of radiation on the liver excludes any comparison on the basis of the physical data alone. Even if identical procedures had been employed, a comparison of the effects on animals of different sizes would be futile. It is obvious that the biologic significance of a given dose, *e.g.*, 1,000 r in air, administered to the whole body of a mouse, would be vastly different than that of the same dose administered to a dog.

The problem of the comparison of effects produced by irradiation is essentially a biological one and can be solved only on a biological basis. Thus, the determination of quantitative effects resolves itself into the problem of finding: (*a*) a readily observable criterion for the radiation effect and (*b*) a biological common denominator applicable to all animal species.

As a criterion for the estimation of the radiation effect we propose the observation of fatty changes in the liver. This suggestion is made for a number of reasons. (*a*) As mentioned above, the fatty changes are of special toxicologic significance. (*b*) The study of the sudanophil fat in microscopic preparations is easy and is facilitated by the fact that in most laboratory animals, under normal conditions, there are only minute amounts of sudanophil fat visible in histologic preparations. We found this true for guinea-pigs, in agreement with Grafflin (53), and we observed similar conditions prevailing in mice. (*c*) The increased postmortem autolysis found in the livers of irradiated animals (120), which might influence the glycogen content, has no influence on the amount of sudanophil substances. This has been established by us in an investigation in which the livers of guinea-pigs and mice simultaneously irradiated were examined, in one instance after death during the night and in another animal of the same lot ten minutes after death on the following morning. (*d*) We agree with Grafflin (53) that estimates of fat content from histologic preparations may not represent the true amount of fat present in the livers, but they seem to be superior to similar estimates of histochemically determined glycogen (Grafflin and associates, 54). (*e*) The procedure suggested takes into account the criticism by Friedman (see Warren, 119) that "the evaluation of minimal or sublethal change is uncertain in cells having as rapid a rate of recovery as liver cells."

As the common biological denominator for the inter-species comparison, the lethal dose of x-rays for the various animal species is suggested. Lethal doses of x-rays have been established by us for various animal species—goldfish, mice, and guinea-pigs (38, 41). Their usefulness has already been proved in various fields of experimental radiation therapy, namely in depth dose determination (Ellinger and Gross, 43) and the study of radiation effects on brain tissue (Ellinger, 42). As a result of these studies, the statement can be made that it is possible to find for any species a dose of x-rays which invariably kills all animals within fourteen days ± 20 per cent. This dose is considered as 100 per cent lethal, or the absolute lethal dose, ALD (41). In mammals increase of the exposure over this threshold value shortens the period between exposure and death of all the animals. This observation is of importance, since in many instances development of changes produced by irradiation requires a certain amount of time.

TABLE II: COMPARISON OF EFFECTS OF VARIOUS LETHAL DOSES OF X-RAYS ON LIVER AND SPLEEN OF GUINEA-PIGS AT DIFFERENT INTERVALS AFTER EXPOSURE

Doses, r in air	Days after exposure	Liver: Fat Content	Spleen: Malpighian Bodies	Remarks
200	12	None	Decrease in white elements	
300	12	None	Smaller; much hemosiderin	
300	20	None	Less distinctly outlined. Very little hemosiderin	Repair process
400	11	Amount of fats same as in controls, but definite central arrangement	Less distinctly outlined. Much hemosiderin	
400	12	Definitely increased amount of fat with central arrangement. In one out of three cases there was an enormous amount of fat	Indistinctly outlined bodies. Increase in fibrous tissue	
400	13	Enormous amount of fat with central arrangement	Malpighian bodies hardly recognizable. Considerable increase of fibrous tissue	
400	24	Definite accumulation of fat around the central vessels; amounts corresponding to those of 11th day	Bodies indistinctly outlined	Repair process
500	13	Some fat in periphery and around central vessels	Malpighian bodies no longer visible; only a few macrophages left	
600	8	Slight increase in fat around central vessels	None	
600	10	Moderate increase in fat, with definite central arrangement in two instances	None	

Thus, the use of multiples of the ALD often obscures certain observations.

The following are the advantages of the use of the ALD as the common biologic denominator in studies of the quantitative effects of irradiation in different animal species:

1. It makes the study more or less independent of the application of identical physical radiation factors. The description of the clinical course observed in the irradiated animals need only be sufficiently elaborate to permit judgment as to whether or not the dose applied was just sufficient to kill all animals within the prescribed period of time, *i.e.*, 14 days ±20 per cent.

2. It permits the inclusion of observations made even in the pioneer days of radiology, when the physical and technical data of exposure were not comparable.

3. It permits the expression of any biologic effect in percentage of the ALD.

2. *Threshold Dose for Liver Injury*

During our previous studies on the lethal dose of x-rays for guinea-pigs, the occurrence of fatty degeneration of the liver was observed (41). For the purpose of a quantitative study of this phenomenon, the results of histologic studies of the livers of 13 irradiated guinea-pigs have been listed in Table II. The corresponding changes observed in the spleens have been included in this tabulation for reasons which will appear later in this paper. The irradiation factors are the same as in the previous study (41).

As can be seen from Table II, up to a dose of 300 r in air no accumulation of fat was observed in the livers of irradiated animals. On the contrary, the absence of even the small amounts of sudanophil fat encountered in some non-irradiated controls was striking. After the application of 400 r in air, however, increasing amounts of sudanophil fat were observed. This dose kills about 80 per cent of the animals within fourteen days and is, therefore, designated as LD^{80} (80 per cent lethal dose) in accordance with the previously adopted designations (41). The LD^{80} seems thus to be *the threshold dose for the production of fatty degeneration in the*

livers of guinea-pigs. With higher doses, *e.g.*, 600 r in air, which is 20 per cent more than the ALD (absolute lethal dose), the latent period between exposure and the first fatalities is shortened. The same decreased latent period is seen in the appearance of fat in the livers, as demonstrated in Table II. This observation is supported by the results of a study made by Clarkson and his associates (21). These authors exposed guinea-pigs to a dose of x-rays corresponding to about three times the ALD for this species. All the animals died within five days and showed "advanced" fatty changes in the livers.

Very interesting with regard to the problem of the threshold dose for liver injury are some results obtained by Maruyama (88). He administered to guinea-pigs a daily dose of x-rays which in previous experiments had been found not to produce fatty changes in the livers. This mode of administration caused the death of the animals within ten to thirteen days after exposure. This accumulated dose corresponded to the ALD (absolute lethal dose). In all instances fatty changes were observed. Thus, daily doses of x-rays, individually too small to produce fatty changes in the livers of guinea-pigs, may produce the appearance of sudanophil fat, if given repeatedly over a period sufficient to accumulate a dose equal in effect to an ALD when applied in a single exposure.

As in guinea-pigs, the livers of mice exposed to a dose of x-rays less than LD^{80} failed to show even traces of fat. After the application of LD^{80} (800 r in air), small amounts of fat were noted between the eighth and tenth days after exposure (41). This fat, however, did not show the definite central arrangement found in the guinea-pigs but was more evenly distributed throughout the lobules. On the fourteenth day after exposure, no sudanophil fat was visible, and for this reason the appearance of the small amounts of fat during the short period between the eighth and tenth days seems to be significant.

The appearance of sudanophil fat in the livers of irradiated mice earlier than in those of guinea-pigs seems to be noteworthy. This observation parallels that on the latent period between exposure and the first occurrence of fatalities in these two species (41) and apparently is one of the expressions of species specificity in reaction to x-rays. In the case of the liver we are able to support this observation by further data. Wels (122) studied the oxygen consumption of dry liver tissue per cubic millimeter, per hour, for various animal species and found the values to be 10.8 and 4.4 for mice and guinea-pigs, respectively. Thus, the greater metabolic rate in the mouse liver easily explains the earlier appearance of fat. The fact that the changes in mice are, however, less pronounced than in guinea-pigs is remarkable. As a general rule, tissues with a greater metabolic rate are more sensitive to irradiation than those with a slower metabolism (39). Consequently mice, which show the greater metabolic rate, should exhibit the more pronounced changes. That this is not the case seems to point to the fact that the changes observed may not be the direct result of irradiation. This matter will be taken up in detail later in this paper.

The transitory and less striking fatty changes in the livers of irradiated mice probably account for the fact that of all the reports of experiments in which definite lethal dose of x-rays were given to mice, only that of Clarkson and his associates (21) mentions the appearance of fat.

Further quantitative data on the appearance of fatty changes in the liver of irradiated animals can be obtained from the literature. Potter (101) has recently demonstrated that rats invariably die within a week after total body exposure to 800 r in air. He found this to be true for radiations of 100 kv. with 0.25 mm. Cu filtration up to 400 kv. with Thoraeus A filter. These data, even if not completely corresponding to our definition of the ALD, could nevertheless be used as an approximate value for the ALD of x-rays for rats. Clarkson and his co-workers (21) found the threshold dose for the appearance of fat in the liver of rats to be 600 r in air (factors:

150 kv., 4 ma., 0.3 mm. Cu filtration). Unfortunately their paper contains no definite figures for the mortality rate with this dose, but it appears to be about 80 per cent. This would be in agreement with the observations of Potter (101).

Russ and associates (104) found that in cats a dose of x-rays which produced about 70 per cent mortality caused fatty changes in the liver, as did also doses causing the death of all animals within nine days. Under the same conditions of exposure, the changes in rabbits were far less pronounced. This is another interesting example of apparent species specificity in the response of the liver to irradiation, and these observations seem to account for the fact that reports on the effect of irradiation on the livers of rabbits do not mention fatty changes.

In summarizing the material concerning the threshold value for the production of fatty changes in the livers of irradiated animals *the following conclusions may be drawn:*

1. There seems to exist a definite threshold value for liver injury following total body irradiation.

2. Irrespective of the animal species used, the threshold dose for liver injury, as expressed by the appearance of increased sudanophil fat, seems to be about LD^{70} to LD^{80} (70 to 80 per cent lethal dose) for the particular species, when the radiation is given in one exposure.

3. Daily application of x-ray doses individually too small to produce fatty changes in the liver may result in such changes if the accumulated dose equals *in effect* an ALD given in a single exposure.

4. The intensity of these changes and the time of their appearance vary with different species.

3. *Relationship between Liver Sensitivity to Total Body and to Local Irradiation*

It is a well known fact that most organs stand considerably larger doses given locally than as total body irradiation. Pohle and Bunting (100) studied the effects of x-rays on the rat liver after exposure to 2,500 r in air (factors: 140 kv., 0.25 mm. Cu and 1.0 mm. Al filtration, field size over the liver 2 × 1.3 cm.). Sacrificing their animals at various intervals up to 30 days after exposure, they found fatty infiltration with a maximum at about the second day after exposure and recurring at about the eleventh day. As mentioned above, with total body irradiation the threshold dose for the appearance of fatty changes was found to be 600 r in air. The far greater resistance of the liver to local irradiation is thus apparent. In this connection it seems worth mentioning that Bolliger and Inglis (12) applied doses up to 5,900 r in air (180 kv.) to the surgically exposed livers of dogs and were able to observe their animals for periods up to 507 days. From all these observations it becomes evident that factors outside the liver contribute largely to the observed liver changes following irradiation.

4. *Relative Sensitivity of the Liver to Radiation*

For the evaluation of the relative sensitivity of the liver, a comparison of the hepatic changes with those simultaneously occurring in the spleen suggests itself, since in previous investigations (41) it has been demonstrated that the lethal effect of x-rays applied in total body irradiation depends largely on the changes produced in the leukopoietic system, especially the spleen. As indicated by Table II, the sensitivity of liver tissue is somewhat less than that of the spleen.

Another comparison which suggests itself is that between the liver and kidneys, because of the close functional association of these two organs. In various instances where fatty changes in the liver were observed, similar observations were made in the kidneys. This is in agreement with the results of a number of investigators in this field. The conditions, however, seem to be rather involved and will be dealt with in detail at a later date. At this time it need only be stated that the kidneys are apparently more resistant to radiation than the liver. Comparative studies of the

influence of irradiation on the oxygen consumption of liver and kidney tissues point in the same direction. A dose of x-rays which produced a 10 per cent reduction of oxygen consumption in kidney tissue, irradiated *in vitro*, reduced the oxygen consumption of liver tissue 40 per cent under the same experimental conditions (Dognon *et al.*, 28).

5. *Summary*

Evidence presented in this paper shows that in various animal species the LD^{80} of x-rays for a particular species, when given to the whole body in one session, produces definite injury to liver cells as indicated by increased amounts of sudanophil fat.

Comparison of the liver changes with simultaneous changes in the spleens of irradiated animals shows that the liver is somewhat less sensitive than the spleen.

The liver, consequently, must be regarded as a radiosensitive organ, as is to be expected from its glandular structure and its high metabolic rate.

MECHANISM OF THE EFFECT OF RADIATION ON THE LIVER

1. *Observations Indicating that Factors Other than the Direct Impact of Radiation Play a Role*

Repeatedly during the discussion of the various aspects of the response of the liver to irradiation we have encountered observations which seem to indicate that factors other than the direct impact of the radiation on that organ are responsible for the effects produced.

1. Clinically, Bromeis (15) found increased urobilinuria not only after prolonged gastro-intestinal fluoroscopy but also after extensive chest fluoroscopy.

2. Holtermann (66) observed increased intravital staining of the livers of mice after isolated irradiation of the head.

3. Changes in the glycogen and glutathione content of the liver were not produced by irradiation *in vitro*.

4. Livers of mice, in spite of their higher metabolic rate, showed less pronounced changes than livers of guinea-pigs.

5. The liver tolerates far greater doses applied locally than in total body irradiation.

From the evidence adduced it is apparent that toxic substances formed within the irradiated body seem to play an important role in the development of liver changes produced by irradiation. This contention is supported by the fact that fatty degeneration of the liver has also been produced, in dogs and rabbits, by irradiation with threshold erythema doses of ultraviolet rays over a longer period of time (Kauffmann, 72; Montanari Reggiani, 92). Since ultraviolet radiation penetrates the skin for only about 0.6 mm., any direct action of this type of rays on the liver is excluded. The effectiveness of ultraviolet rays in producing liver changes and other organ effects (Ellinger, 31, 32, 34–37) is largely dependent upon their ability to produce a skin erythema. This phenomenon has been proved to be due to histamine-like substances or even histamine itself (Ellinger, 39). It may, therefore, be assumed that histamine-like substances play some part in producing the changes in the livers of animals after x-ray irradiation.

2. *The Histamine Theory of Radiation Effects and Liver Changes*

As previously explained (Ellinger, 39), the histamine theory has been proved valuable for the understanding of many of the effects of radiation. Its merits for the proper understanding of the response of the liver to irradiation rest upon the following observations.

1. Injection of histamine into animals is able to produce the same chemical changes in the liver as are observed after irradiation (Feldberg and Schilf, 47).

2. Injection of histamine produces increased bile secretion (Baltacéano and Vasiliu, 5; Feldberg and Schilf, 47), which is observed, also, after the application of smaller doses of x-rays.

3. Chronic injection of histamine produces in dogs the same histologic picture as irradiation, including extensive accumulation of sudanophil fat around the cen-

tral vessels of the lobules (Eppinger and Leuchtenberger, 45; Hueper and Ichniowski, 68).

This short review demonstrates the striking resemblance between the effects of histamine and irradiation on the liver. The assumption that histamine plays an important role in the production of the radiation effects on the liver with respect to function and structure seems well founded. In the light of the histamine theory the following observations are easily understood:

1. The less intensive response of the liver of the mouse to irradiation as compared with the guinea-pig. Mice are about 1,000 times more resistant to histamine than guinea-pigs (Feldberg, 46; Feldberg and Schilf, 47).

2. The species differences observed in the radiation effect on the liver in the cat and the rabbit. While it is true that the resistance of these two animal groups to acute intoxication with histamine is of approximately the same order, the rabbit detoxifies slowly injected histamine more easily than the cat (Feldberg and Schilf, 47, p. 87). The liberation or formation of histamine-like substances during irradiation corresponds to a slow injection, which would explain the less pronounced changes in rabbits.

3. The greater tolerance of the liver to local application of x-rays than to total body irradiation. , The greater total irradiated volume would obviously contribute a greater amount of histamine-like substances.[4] Thus the same dose of x-rays distributed over the entire body becomes more toxic so far as the liver is concerned.

4. The observation by Bromeis (15) that extensive fluoroscopy of the thorax produces increased urobilinuria. Pulmonary tissues are among those having the highest content of histamine (Feldberg and Schilf, 47). It may be that some of this is liberated by the doses received during intensive fluoroscopy of the lungs (Bell, 7).

[4] We are fully aware that influences on other organs of the body may also contribute to the increased toxicity of total body irradiation.

In summary, the histamine theory of radiation effects seems to explain all those observations concerning the response of the liver to irradiation which cannot be explained as effects of the direct impact of the rays.

ACKNOWLEDGMENT: The writer expresses his gratitude to Dr. A. L. L. Bell, Director of the Department of Radiology of the Long Island College of Medicine, for his kind interest and support of this investigation, and to Dr. J. M. Pearce of the Department of Pathology for reviewing the histological findings.

Long Island College Hospital
Brooklyn 2, N. Y.

REFERENCES

1. ABDERHALDEN, R.: Beitrag zum Problem der biologischen Strahlenwirkungen. Die Feststellung der Empfindlichkeit der Organe gegenüber Röntgenstrahlen in vivo mit Hilfe einer biochemischen Methode. Strahlentherapie **68:** 17–29, 1940.

2. AUBERTIN AND BEAUJARD: À propos de l'action des rayons X sur la glycogénie hépatique. Bull. et mém. Soc. méd. d. hôp. de Paris **28:** 722–725, 1909.

3. AZZI, E., AND LASCHI, G.: Irradiazione röntgen a distanza con piccole dosi e crasi sanguigna. Riv. d. radiol. e fis. med. **3:** 539–566, July 1931.

4. BACH, E.: Zur Frage der Schädlichkeit der Röntgenstrahlen beim Röntgenpersonal und bei den Patienten. Strahlentherapie **69:** 95–120, 1941.

5. BALTACÉANO, G., AND VASILIU, C.: À propos de l'histamine et la sécrétion biliaire. Compt. rend. Soc. de biol. **119:** 221–224, 1935.

6. v. BARBACZY, M.: Die Änderungen des Blutcholesteringehaltes nach Röntgentiefenbestrahlungen. Strahlentherapie **19:** 531, 1925.

7. BELL, A. L. L.: X-Ray Therapy in Fluoroscopy. Radiology **40:** 139–144, February 1943.

8. BENASSI, E.: Irradiazione roentgen e clorazione vitale degli elementi reticoloendoteliali. Radiol. med. **16:** 874–891, September 1929.

9. BEUTEL, A.: Zur Beeinflussung der Leberfunktion durch Röntgenstrahlen. Strahlentherapie **45:** 344–348, 1932.

10. BEUTEL, A., AND WINTER, K. A.: Das Gewebechlor bei der Ratte nach Röntgentotalbestrahlung. Strahlentherapie **54:** 89–95, 1935.

11. BIANCHI, C.: Ricerche sperimentali sulle modificazione di funzionalità epatica dopo irradiazione roentgen del fegato. Scr. ital. radiobiol. med. **5:** 3, 1938.

12. BOLLIGER, A., AND INGLIS, K.: Experimental Liver Disease Produced by X-Ray Irradiation of the Exposed Organ. J. Path. & Bact. **36:** 19–30, January 1933.

13. BORAK, J., AND KRISER, A.: Zur Frage der Beziehung zwischen "Röntgenkater" und Leberbestrahlung. Med. Klin. **19:** 644, May 13, 1923.

14. BRAMS, J., AND DARNBACHER, L.: Effect of X-Rays on the Gall Bladder: Experimental Production of an X-Ray Cholecystitis. Radiology **13:** 103–108, August 1929.

15. BROMEIS, H.: Urobilinogenausscheidung im Harn nach Röntgenbestrahlung und Durchleuchtung. Strahlentherapie **23:** 687–701, 1926.

16. CALLIERIO, G.: L'azione dei raggi X sul sistema reticolo-endoteliale. Radiol. med. **18:** 768–785, June 1931.

17. CALÒ, A.: Über das Verhalten des retikuloendothelialen Apparates bei Bestrahlung von Geschwülsttieren. Strahlentherapie **46:** 529–544, 1933.

18. CASATI, A., AND CAFISSI, G.: Ricerche sperimentali (radiotenatogiche) sul fegato irradiato a contetto. Radiol. e fis. med. I, 3 Suppl., 81, 1937.

19. CASE, J. T., AND WARTHIN, A. S.: Occurrence of Hepatic Lesions in Patients Treated by Intensive Deep Roentgen Irradiation. Am. J. Roentgenol. **12:** 27–46, July 1924.

20. CHROM, S. A.: Studies on the Effect of Roentgen Rays upon the Intestinal Epithelium and upon the Reticulo-Endothelial Cells of the Liver and Spleen. Acta radiol. **16:** 641–660, 1935.

21. CLARKSON, J. R., MAYNEORD, W. V., AND PARSONS, L. D.: Effect of X-Radiation on the Blood and Lymphoid Tissue of Tumour-Bearing Animals. J. Path. & Bact. **46:** 221–235, March 1938.

22. CLAUSER, F.: Azione dei raggi roentgen sulla funzione granulo-pessica degli elementi retcolo-endoteliali dell' utero. Monit. ostet.-ginec. **1:** 394, 1929.

23. CRAMER, H., AND WALLBACH, G.: Strahlenwirkung und Mesenchymfunktion. Arch. f. exper. Zellforsch. **11:** 233–241, June 10, 1931.

24. CZEPA, A., AND HÖGLER, F.: Über den Einfluss der Röntgen- und Radiumstrahlen auf die Leber. Med. Klin. **18:** 1087–1090, Aug. 20, 1922.

25. DAVISON, C., AND ELLINGER, F.: Radiation Effects on Nervous System and Roentgen-Pigmentation of Goldfish (*Carassius auratus*). Proc. Soc. Exper. Biol. & Med. **49:** 491–495, March 1942.

26. DELLEPIANE, G.: Ricerche sull'influenza esercitata dai raggi röntgen sull'attività granula-pessica del sistema reticolo-endoteliale. Arch. internat. pharmacodyn. et de thérapie **39:** 294–304, 1930.

27. DESJARDINS, A. U.: Reaction of Abdominal Tumors to Radiation. J. A. M. A. **83:** 109–113, July 12, 1924.

28. DOGNON, A., LEVIN, B. S., AND NACHMANSOHN, D.: Sur la différence de la radiosensibilité du foie et du rein isolés du cobaye. Compt. rend. Soc. de biol. **122:** 1083–1084, 1936.

29. DOUB, H. P., BOLLIGER, A., AND HARTMAN, F. W.: Relative Sensitivity of the Kidney to Irradiation. Radiology **8:** 142–148, February 1927.

30. DRUCKREY, H., LÖW-BEER, A., AND REISS, M.: Untersuchung über die Beeinflussung der Gewichtskurve von Ratten und Mäusen durch Röntgenstrahlen. Ztschr. f. d. ges. exper. Med. **83:** 115–127, 1932.

31. ELLINGER, F.: Über die Lichtempfindlichkeit der "vegetativ Stigmatisierten" und ihre Bedeutung für die Klinik des Magenschwüres. Ztschr. f. klin. Med. **122:** 272–280, 1932.

32. ELLINGER, F.: Über Ergebnisse der lichtbiologischen Konstitutionsforschung an Lungentuberkulösen und ihre Bedeutung für die Heliotherapie der Lungentuberkulose. Strahlentherapie **48:** 759–765, 1933.

33. ELLINGER, F.: Zellpermeabilität und Strahlenwirkung. Strahlentherapie **58:** 464–469, 1937.

34. ELLINGER, F.: Histamine and the Action of the Thyroid Gland. Nature, London **141:** 1014, June 4, 1938.

35. ELLINGER, F.: Acetonitril Test for Thyroid according to Reid Hunt and Irradiation with Ultraviolet Light. Radiologica **3:** 195, 1938.

36. ELLINGER, F.: Ultraviolet Licht und Krebs. Fundamenta Radiologica **4:** 181, 1939.

37. ELLINGER, F.: Influence of Ultra-Violet Rays on the Body Weight. Radiology **32:** 157–160, February 1939.

38. ELLINGER, F.: The Goldfish as a New Biologic Test Object in Experimental Radiation Therapy. Radiology **35:** 563–574, November 1940.

39. ELLINGER, F.: Biologic Fundamentals of Radiation Therapy. New York, Elsevier Publishing Co., 1941.

40. ELLINGER, F.: Direct or Indirect Action of Roentgen Rays on the Brain. Am. J. Roentgenol. **47:** 775–776, May 1942.

41. ELLINGER, F.: Lethal Dose Studies with X-Rays. Radiology **44:** 125–142, February 1945.

42. ELLINGER, F., AND DAVISON, C.: Changes in the Central Nervous System of Goldfish Irradiated in the Depths of a Water Phantom. Radiology **39:** 92–95, July 1942.

43. ELLINGER, F., AND GROSS, R.: Depth Dosage Measurements by Means of Goldfish. Radiology **37:** 717–722, December 1941.

44. ELMAN, R., AND MCMASTER, P. D.: Studies on Urobilin Physiology and Pathology. IV. Urobilin and the Damaged Liver. J. Exper. Med. **42:** 99–122, July 1925.

45. EPPINGER, H., AND LEUCHTENBERGER, R.: Zur Pathogenese der Lebercirrhose. Ztschr. f. d. ges. exper. Med. **85:** 581–597, 1932.

46. FELDBERG, W.: Histamine and Anaphylaxis. Ann. Rev. Physiol. **3:** 671–694, 1941.

47. FELDBERG, W., AND SCHILF, E.: Histamin. Seine Pharmakologie und Bedeutung für die Humoralphysiologie. Berlin, Julius Springer, 1930.

48. FISCHEL, E.: Recherches expérimentales sur l'influence des rayons X sur la production ou accumulation de bile et de glycogène dans la cellule hépatique. Schweiz. med. Wchnschr. **71:** 764–769, June 21, 1941.

49. FROMME, G.: Über die allgemeine Wirkung der Röntgen- und Radiumstrahlen. Ztschr. f. Geburtsh. u. Gynäk. **79:** 579, 1916.

50. GABRIEL, G.: Die Beeinflussung von Tierorganen durch Röntgenbestrahlung. Strahlentherapie **22:** 107–124, 1926.

51. GERMER, K.: Om Roentgenstraalernes indvirkning paa levern. Ugesk. f. laeger **95:** 784–791, July 13, 1933.

52. GERMER, K., AND MELLEMGAARD, A.: Nogle Undersøglser over Leberfunktionen før og efter de almindeligt i Kliniken anvendte røntgenologiske Undersøgelser af ventriclen. Ugesk. f. laeger **96:** 124–136, Feb. 1, 1934.

53. GRAFFLIN, A. L.: Histological Study of Fat Distribution in Guinea-Pig Livers. Anat. Rec. **77:** 473–485, Aug. 26, 1940.

54. GRAFFLIN, A. L., MARBLE, A., AND SMITH, R. M.: Histological Estimation versus Chemical Analysis of Liver Glycogen. Anat. Rec. **81:** 495–497, Dec. 26, 1941.

55. GRAHAM, J. S.: Effect of Carbon Arc Irradiation and Adrenal Cortical Preparations on Capillary Permeability. Proc. Soc. Exper. Biol. & Med. **54:** 101–102, October 1943.

56. HAJÓS, K., AND HOFHAUSER, S.: Über den Einfluss der Röntgenbestrahlung auf die postmortale Leberautolyse. Biochem. Ztschr. **146:** 204–207, 1924.

57. HALBERSTAEDTER, L., AND WOLFSBERG, O.: Funktionssteigerung und -schädigung von röntgenbestrahlten tierischen Geweben im Lichte der Vitalfärbung. Ztschr. f. d. ges. exper. Med. **32:** 367–377, 1923.

58. HALL, C. C., AND WHIPPLE, G. H.: Roentgen Intoxication: Disturbances in Metabolism Produced by Deep Massive Doses of Hard Roentgen Rays. Am. J. M. Sc. **157:** 453–482, April, 1919.

59. HARDE, E., AND KOBIZIEFF, N.: Sarcome du rat, irradiation hépatique et acide ascorbique. Compt. rend. Soc. de biol. **122:** 882–884, 1936.

60. HARTOCH, W., AND ISRAELSKI, M.: Zur Wirkung der Röntgenstrahlen auf die Funktion sezernierender Organe . . . . die Leber. Strahlentherapie **44:** 557–574, 1932.

61. HAYASHI, T., AND MARUYAMA, K.: Die Leber des sensibilisierten Tieres und die Ursache des sogenannten "Röntgenkaters." Fortschr. a. d. Geb. d. Röntgenstrahlen **55:** 346–351, April 1937.

62. HEEREN, J.: Chemische Veränderungen der

Eiweisskörper in vivo während und nach Röntgenbestrahlung von Lebergewebe. Strahlentherapie **56:** 88–96, 1936.

63. HEEREN, J., AND PANSDORF, J.: Gewebsatmung nach Röntgenbestrahlung. Experimentelle Untersuchungen an Leber und Niere. Strahlentherapie **42:** 307–327, 1931.

64. HEINEKE, H.: Über die Einwirkung der Röntgenstrahlen auf Tiere. München. med. Wchnschr. **50:** 2090–2092, 1903.

65. HINO, S.: Über die Wirkung der Röntgenstrahlen auf die neugeborenen Säugetiere. Mitt. d. med. Gesellsch. zu Tokio **46:** 1598, September 1932. Abst. in Zentralbl. f. d. ges. Radiol.

66. HOLTERMANN, C.: Über vitale Gewebefärbung unter dem Einfluss von Röntgenstrahlen. Strahlentherapie **17:** 158–174, 1924.

67. HUDELLET, G. J.: Action des rayons X sur le foie. Arch d'électric. méd. **15:** 7–21, 1907.

68. HUEPER, W. C., AND ICHNIOWSKI, C. T.: Experimental Studies in Cardiovascular Pathology. VIII. Late Vascular Reactions of Histamine Shock in Dogs. Am. J. Path. **20:** 211–221, January 1944.

69. JASWOIN: Über die Wirkung der Radiumemanation auf die Leber der Frosche. Westnik Roentg. i Radiol **4:** 305–310, 1926. Quoted from Nemenov in Handbuch der gesamte Strahlenheilkunde, edited by P. Lazarus. Berlin, Julius Springer, Vol. I, 1927.

70. JÜNGLING, O.: Die Strahlenbehandlung der bösartigen Geschwülste, in Handbuch der gesamten Strahlenheilkunde, edited by P. Lazarus. Berlin, Julius Springer, Vol. II, Section 3, 1929, p. 570.

71. KARSNER, H. T.: Human Pathology. Philadelphia, J. B. Lippincott Co., 6th ed., 1942.

72. KAUFFMANN, F.: Experimentelles zur Gastritisfrage. Deutsche med. Wchnschr. **55:** 1745, Oct. 18, and 1795, Oct. 25, 1929.

73. KELLER, E.: Die Wirkung intensiver Röntgenbestrahlung auf den Darm und ihre Folgeerscheinungen. Ztschr. exper. Path. u. Therap. **22:** 284, 1927.

74. KOLODNY, A.: Tissue Changes after Experimental Deep Roentgen Irradiation. Am. J. Path. **1:** 285–293, May 1925.

75. KRAUSE, P., AND ZIEGLER, K.: Experimentelle Untersuchungen über die Einwirkung der Röntgenstrahlen auf tierisches Gewebe. Fortschr. a. d. Geb. d. Röntgenstrahlen **10:** 126–182, 1906.

76. LAPENNA, M., AND MONTEMARTINI, G.: Modificazione delle colestrina nel sangue, fegato, milza e rene dopo irradiazione con raggi di variat unghezza d'onda. Scr. ital. radiobiol. med. **5:** 113, 1938.

77. LAURENS, H., AND GRAHAM, J. S.: Influence of Adrenal Cortex and of Doses of Desoxycorticosterone Acetate on the Blood Pressure Lowering Effect of Carbon Arc Radiation. M. Rec. **154:** 146–147, Aug. 20, 1941.

78. LAWRENCE, J. A., AND TENNANT, R.: Comparative Effects of Neutrons and X-Rays on the Whole Body. J. Exper. Med. **66:** 667–688, December 1937.

79. LAZARUS-BARLOW, A.: in Medical Uses of Radium. Special Report Series No. 62, Medical Research Council. His Majesty's Stationery Office, London, 1922.

80. LEBLOND, C. P., NGUYEN-VAN-THOAI, AND SEGAL, G.: Infiltration graisseuse du foie sous l'action des agents nocifs. Compt. rend. Soc. de biol. **130:** 1557–1559, 1939.

81. LEBLOND, C. P., AND SEGAL, G.: Differentiation between Direct and Indirect Effects of Roentgen Rays upon Organs of Normal and Adrenalectomized Rats. Am. J. Roentgenol. **47:** 302–306, February 1942.

82. LEACH, J. E., AND SUGIURA, K.: Effect of High Voltage Roentgen Rays on the Heart of Adult Rats. Am. J. Roentgenol **45:** 414–425, March 1941.

83. LÉPINE, R., AND BOULUD: Action des rayons X sur les tissus animaux. Compt. rend. Acad. d. sc., Paris **138:** 65–67, 1904.

84. LÖW-BEER, A.: Experimentelle Untersuchungen zur Frage der biologischen Röntgenstrahlenwirkung. Strahlentherapie **46:** 469–516, 1933.

85. LONDON, E. S.: Weitere Untersuchungen der Radiumwirkungen. Berl. klin. Wchnschr. **42:** 1336–1338, 1905.

86. LÜDIN, M.: Leberveränderungen nach Röntgenbestrahlung. Strahlentherapie **19:** 138–141, 1925.

87. MAGATH, M. A.: Änderungen der Zellpermeabilität durch Röntgenbestrahlung, gemessen an der Phosphatausscheidung überlebender Tumor- und Leberschnitte. Ztschr. f. Krebsforsch. **31:** 95–104, 1930.

88. MARUYAMA, K.: Experimentelle Untersuchungen über den Röntgenkater und Röntgentod. Fortschr. a. d. Geb. d. Röntgenstrahlen **46:** 85–94, July 1932.

89. MENDELÉEFF, P.: Action des irradiations sur l'organisme des cobayes. Compt. rend. Soc. de biol. **94:** 1274–1277, 1926.

90. MILLS, G. P.: Effect of Radium on the Healthy Tissue Cell. Lancet **2:** 462, 1910.

91. MOON, V. H., KORNBLUM, K., AND MORGAN, D. R.: Pathology of Irradiation Sickness: New Method of Inducing Shock. Proc. Soc. Exper. Biol. & Med. **43:** 305–306, February 1940.

92. MONTANARI REGGIANI, M.: Contributo sperimentale alla conoscenza della azione fisiopatologica delle irradiazioni ultraviolette ripetute in zone cutanee circoscritte. Ann. ital di chir. **14:** 831–892, August 1935.

93. MORIYA, C.: Über die Wirkung der Kathodenstrahlen auf die Leber beim Kaninchen, besonders über ihre vergleichende Untersuchung mit der X-Strahlen. II. Über die Veränderung der Mitochondrien der Leberzellen. Okayama-Igakkai-Zasshi **46:** 819–822, April 1934. Abst. in Berichte über die ges. Physiol.

94. MOSSE, M.: Über metalymphämische Lebercirrhose. Berl. klin. Wchschr. **45:** 1219–1221, 1908.

95. NATHANSON, A. O., AND TSCHERKES, G. A.: Wirkung der Röntgenstrahlen auf das Glutathion der Leber. Strahlentherapie **55:** 96–103, 1936.

96. NEUDA, P.: Über eine Beziehung der Leber zum Chlorhaushalt. Wien. med. Wchnschr. **73:** 1484, 1923.

97. PACK, G. T., AND LIVINGSTON, E. M.: Palliative Therapy of Gastric Cancer. Chapter 48 in Cancer and Allied Diseases, edited by Pack and Livingston, New York, Paul B. Hoeber, Inc., Vol. II, 1940.

98. PALMER, W. L., AND TEMPLETON, F. E.: Effect of Radiation Therapy on Gastric Secretion. J. A. M. A. **112:** 1429–1434, April 15, 1939.

99. v. PANNEWITZ, G.: Beeinflussung des Kohlehydratstoffwechsels durch Leberbestrahlung. Fortschr. a. d. Geb. d. Röntgenstrahlen (Kongresshft.) **36:** 74, 1927.

100. POHLE, E. A., AND BUNTING, C. H.: Studies of the Effect of Roentgen Rays on the Liver. Acta radiol. **13:** 117–124, 1932.

101. POTTER, J. C.: Biological Effect of Roentgen Rays of Long and Short Wavelength on the Totally Irradiated Rat. Radiology **37:** 724–725, December 1941.

102. RECHENBERGER, J., PATZELT, K., AND SCHAIRER, E.: Der Vitamin A-Gehalt der Leber nach Röntgenbestrahlung. Klin. Wchnschr. **20:** 361–362, April 12, 1941.

103. ROTHER, J.: Über den Angriffspunkt der Röntgenstrahlenwirkung am biologischen Objekt. Strahlentherapie **27:** 197–256, 1927.

104. RUSS, S., WRIGHT, S., BULMAN, H. A., AND CLARK, L. H.: Physiological and Cytological Effects of Penetrating X-Rays upon Cat and Rabbit. Proc. Roy Soc. Med. **23:** 1671, 1930.

105. SCHMIDT, E. A.: Experimentelle und histologische Untersuchungen über den Einfluss der Röntgen-

strahlen auf die vitale Färbbarkeit der Gewebe. Strahlentherapie **12:** 517–548, 1921.

106. SCHWIENHORST, M.: Untersuchungen über den Einfluss von Röntgenbestrahlungen auf die Kokkenphagocytose im Reticuloendothel. Beitr. z. path. Anat. u. z. allg. Path. **81:** 375–390, Dec. 17, 1928.

107. SELDIN, M.: Über die Wirkung der Röntgen- und Radiumstrahlen auf innere Organe und den Gesamtorganismus der Tiere. Fortschr. a. d. Geb. d. Röntgenstrahlen **7:** 322–339, 1904.

108. SMYTH, F. S., AND WHIPPLE, G. H.: Bile Salt Metabolism. II. Proteose and X-Ray Intoxication. J. Biol. Chem. **59:** 637, April 1924.

109. SOLLMANN, T.: A Manual of Pharmacology. Philadelphia, W. B. Saunders Co., 1943.

110. TAKEDA, T., AND YOUEN, K.: Über den Einfluss der Röntgenstrahlen auf die Verdauungsorgane. Okayama-Igakkai-Zasshi, 1926, 80. Abst in Zentralbl. f. d. ges. Radiol. **1:** 185, 1926.

111. TANG, Y. H.: Les bases expérimentales de la radiothérapie totale et subtotale. J. belge radiol. **28:** 207, 1939.

112. THIELE, W., AND HARTKOPF, W.: Über den Einfluss der Röntgenstrahlen auf die Vitamin A-Haushalt. Klin. Wchnschr. **19:** 1010–1013, 1940.

113. THIESS, A. E.: Wirkung der Radiumstrahlen auf verschiedene Gewebe und Organe. Mitt. a. d. Grenzgeb. d. Med. u. Chir. **14:** 694–725, 1905.

114. TRIBONDEAU, L., AND HUDELLET, G.: Action des rayons X sur le foie du chat nouveau-né. Compt. rend. Soc. de biol. **62:** 102–104, 1907.

115. TSCHASSOWNIKOW, N.: Über die Wirkung der Röntgenstrahlen auf den feinen Bau der Leberzellen beim Frosch. Virchows Arch. f. path. Anat. **269:** 166–177, 1928.

116. TSUKAMOTO, R.: Über die Stoffwechsel störungen nach Bestrahlung der Leber mit Röntgenstrahlen. Strahlentherapie **18:** 320–368, 1924.

117. TSUZUKI, M.: Experimental Studies on the Biological Action of Hard Roentgen Rays. Am. J. Roentgenol. **16:** 134–150, August 1926.

118. WAIL, S. S., AND FRENKEL, S. R.: Über den Einfluss der Röntgenstrahlen auf das Zellplasma. Virchows Arch. f. path. Anat. **257:** 846–850, 1925.

119. WARREN, S.: Effects of Radiation on Normal Tissues. IV. Effect of Radiation on the Gastrointestinal Tract, Including Salivary Glands, Liver and Pancreas, by N. B. Friedman. Arch. Path. **34:** 749–787, October 1942.

120. WARREN, S. L., AND WHIPPLE, G. H.: Roentgen Ray Intoxication III. J. Exper. Med. **35:** 187–203, February 1922.

121. WARTHIN, A. S.: Changes Produced in Kidneys by Röntgen Irradiation. Am. J. M. Sc. **133:** 736–746, May 1907.

122. WELS, P.: Der Einfluss der Tiergrösse auf die Oxydationsgeschwindigkeit im überlebenden Gewebe. Arch. f. d. ges. Physiol. **209:** 32–48, 1925.

123. WERNER, R.: Vergleichende Studien zur Frage der biologischen und therapeutischen Wirkung der Radiumstrahlen. Beitr. z. klin. Chir. **52:** 51–161, 1906.

124. WETZEL, E.: Röntgenschädigungen mit und ohne Beteilung der Haut. Strahlentherapie **12:** 585–594, 1921.

125. WINDHOLZ, F.: Über die Strahlentherapie und Strahlenbiologie der Tumoren und tumorartigen Hyperplasien des retikuloendothelialen Systems. Strahlentherapie **58:** 406–429, 1937.

126. WINTZ, H.: Strahlenschäden und Strahlenschutz. In Handbuch der gesamten Strahlenheilkunde, edited by P. Lazarus, Berlin, Julius Springer, Vol. II, Section 1, 1927, pp. 113–193.

Congenital Solitary Pelvic Ectopic Kidney, with Report of a Case[1]

B. H. NICHOLS, M.D., and J. T. MARR, M.D.
Cleveland Clinic, Cleveland, Ohio

A SOLITARY pelvic or ectopic kidney is a rare anomaly if its frequency is to be judged by reported cases. Because the kidney is single, other abnormalities of form, such as a fused kidney, are not included in this classification.

In 1937 Stevens (1) reviewed the literature and tabulated the findings in 27 cases including 2 of his own. He estimated that a single pelvic kidney occurred once in every 22,000 births. He also stressed the importance of urologic management of such cases and the frequent association with genital anomalies in women.

Details of the cases reported since Stevens' publication are presented in Table I. Houtappel's (2) patient was sixty-eight years old. The oldest patient reported previously was forty-eight; the average age was sixteen. Houtappel pointed out the importance of excretory urography or retrograde pyelography before every kidney operation. Ockerblad's and Carlson's case (3) is interesting because the patient had two uneventful pregnancies and deliveries. In fact, the only time she was free from albuminuria was during these pregnancies. Mayers (4) reported an additional case and proposed a classification for renal anomalies. He also suggested that the designation "congenital solitary pelvic renal ectopia" be substituted for "pelvic single kidney." Ogden and Maltry (5) added another case, briefly reviewed the embryology of the kidney, and presented an explanation for unilateral renal agenesis. Planas and Fablet's patient (6) had one delivery which required the aid of forceps and a second which was normal.

TABLE I: PUBLISHED CASES OF SINGLE PELVIC KIDNEYS, 1937–1943

Case No.*	Age and Sex	Anomalies	Clinical Diagnosis	Urologic Findings
28 (Houtappel, 1937)	68 M	Mentally defective	Anuria due to bilateral ureteral calculus	Right ureteral orifice only. Single pelvic kidney with stone in the calix
29 (Ockerblad and Carlson, 1940)	36 F	Left tube and ovary absent	Solitary pelvic ectopic kidney	Right ureteral orifice only. Kidney weighed 40 gm.
30 (Mayers, 1940)	33 M	No abnormalities	Solitary pelvic ectopic kidney	Left half of trigone absent. No left ureteral orifice. Right ureteral orifice involved with small ureterocele
31 (Ogden and Maltry, 1940)	17 F	Absence of vagina, uterus tubes, and appendix. Ovaries and sigmoid displaced	Pelvic mass assumed to be uterus	Left ureteral orifice only. Kidney overlying sacrum. Renal pelvis slightly dilated
32 (Planas and Fablet, 1940)	31 F	No abnormalities	Uterine fibroid	Excretory urogram and pyelogram show a solitary pelvic ectopic left kidney. Absence of right ureteral orifice
33 (Nichols and Marr, 1945)	20 F	Uterus and tubes absent. Ovaries not identified	Pelvic kidney thought to be uterus	Excretory urogram postoperatively showed ectopic kidney of normal size

* Twenty-seven cases seen up to 1937 were tabulated by Stevens (1).

[1] Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

Fig 1. Congenital solitary pelvic ectopic kidney.

CASE REPORT

A woman, aged twenty, came to the Cleveland Clinic in October 1939 because she had never menstruated. She had been happily married for three years. She had no symptoms referable to the urinary tract and felt perfectly well generally. Four sisters were normal.

Examination showed a well developed, well nourished woman. The breasts were about average for a young adult female. The external genitalia were normal. The vagina admitted two fingers and appeared normal except that it was somewhat short and that no cervix could be palpated. On rectal examination a mass was felt, extending from the upper left to the lower right posterior pelvis and tapering to a small point at the lower end. The examiner thought that this might be the uterus and decided to do an exploratory laparotomy. If the mass were found to include the uterus and cervix, he was prepared to consider the possibility of connecting them to the vagina.

On five urinalyses the specific gravity of the urine ranged from 1.020 to 1.032, and the *p*H from 5.0 to 7.5. Results of tests for sugar were negative. A trace of albumin was found twice, a few granular casts once, and an occasional red blood cell three times. The blood urea was 45 mg. per 100 c.c. The kidneys were obscured on a roentgenogram of the kidney, ureter, and bladder region.

In January 1942 the patient was admitted to the Cleveland Clinic Hospital for operation. A lower abdominal midline incision was made, and in the hollow of the sacrum a kidney of normal size was found, whose pedicle extended upward along the left side of the vertebral column toward the normal point of exit of the renal vessels. No kidneys could be palpated in the normal kidney area. The upper end of the vagina, which had been packed with gauze preoperatively, could be seen. No uterus, tubes, or ovaries were present in the pelvis. The incision was closed, and the postoperative course was uneventful.

On the eleventh postoperative day an excretory urogram was done. There was no evidence of a kidney on the left. The right kidney was in the pelvis—a congenital solitary pelvic kidney (Fig. 1).

This case illustrates the necessity for an excretory urogram in the presence of a suspicious mass in the pelvis and anomalous development or absence of the uterus, tubes, or ovaries, or when a kidney is not demonstrable roentgenographically.

DISCUSSION

The earliest recognition of this anomaly was in an eight-month fetus. This was the first case to appear in the literature, being reported in 1830. A number of examples were discovered at autopsy. Kidney stones were found in 4 cases. In 2 instances the solitary kidney was removed as a tumor. A nephrostomy was performed in 1 case, and a lithotomy in 2 cases. All were successful operations.

The reproductive and excretory systems are closely related in their development. Both originate in the mesoderm. At an early embryonic age the dorsal surface of the mesoderm thickens and forms the wolffian ridge. From the principal portion of this ridge the primary excretory organs develop. On the mesial side, however, a second ridge appears, known as the genital ridge, from which the ovaries and testes develop.

Excretory organs develop in three distinct stages. The pronephros is only a temporary development except for the duct, which becomes the wolffian duct and develops into primary renal pelvis and the ureter. The second primary development is the mesonephros, or the wolffian body. The third and final stage is the metanephros, which is associated with the development of the reproductive organs.

From the genital ridge the müllerian

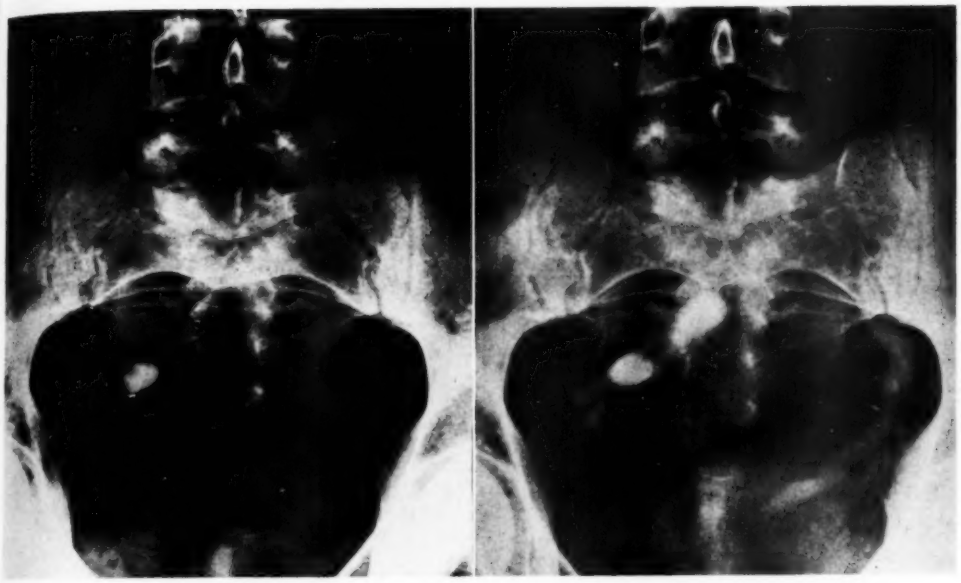

Fig. 2 (left). Roentgenogram showing calculus in lower ureteral area.
Fig. 3 (right). Urogram showing the calculus shown in Fig. 2 to be in a pelvic kidney.

ducts develop. These ducts make contact and finally fuse to form the uterovaginal canal.

The metanephros is the permanent kidney and appears about the fourth week of embryonic life. The ureter develops from the wolffian duct. At first this is a tubular bud, but it grows upward and divides to form the major calices, which also divide to form the minor calices. It is evident from the embryologic picture that congenital variations in the reproductive and excretory organs are a likely possibility.

From their inception, the kidneys are separate organs. Consequently, one kidney may be definitely anomalous or remain in a pelvic position, while the opposite kidney is normal. On the other hand, one kidney may be entirely absent, while the remaining one is anomalous. The kidneys begin their ascent and rotation early in embryonic life and usually reach their final position and proper rotation at the end of the ninth week. It is believed that the permanent renal vessels develop and are united with the kidney at this time.

It was formerly believed that the kidney was supplied by vessels along its course of ascent and that such vessels sometimes became fixed and accounted for the position of a pelvic or ectopic kidney. This is probably fallacious, even though the blood supply to an ectopic kidney sometimes comes from the bifurcation of the aorta in the lower abdomen. The subsequent development of the ureter is continuous during the period of normal growth. The kidney actually rises but a very short distance in the embryo, and further migration is simply a matter of general body growth. The ureter grows sufficiently in length to reach the kidney in its final position.

One may then conclude that absence of one kidney may be due to complete failure of the ureteral bud to develop or to early degeneration of the ureteral bud. In most instances the anomaly will be accompanied by absence of the corresponding ureter and also of the ureteral orifice in the bladder. As the rotation of the kidney on its long axis occurs during its ascent in early embryonic development, the ectopic or pelvic kidney usually shows no rotation.

The pelvis lies anteriorly or medially and on the pyelogram or urogram is usually observed as a bizarre kidney pelvis. That the ureter of the pelvic kidney is usually only long enough to drain the kidney is frequently an important fact in differentiating a ptosis of a normal kidney and an ectopic pelvic kidney.

There is always the possibility of mistaking a pelvic kidney for a tumor. One of our patients had two exploratory operations in an attempt to remove a supposed ureteral calculus. The notes of the second operation stated that a mass was found in the pelvis and that the calcification was evidently in this tumor (Figs. 2 and 3). The excretory urogram, however, showed the mass to be an ectopic kidney with a stone.

We wish to emphasize the danger of removing a solitary pelvic kidney erroneously diagnosed as a tumor. Before operation is undertaken, an excretory urogram or cystoscopic examination, with a pyelogram, is extremely important in all cases of congenital anomalies of the reproductive organs in the female, atypical masses in the pelvis, or low-lying calculi when there is no history of symptoms indicating passage down the ureter.

2020 E. 93d St.
Cleveland 6, Ohio

REFERENCES

1. STEVENS, A. R.: Pelvic Single Kidneys. J. Urol. **37:** 610–618, May 1937.
2. HOUTAPPEL, H. C. E. M.: Case of Pelvic Single Kidney. Brit. J. Urol. **9:** 372–376, December 1937.
3. OCKERBLAD, N. F., AND CARLSON, H. E.: Solitary Pelvic Ectopic Kidney. Brit. J. Urol. **12:** 43–48, March 1940.
4. MAYERS, M. M.: Congenital Solitary Pelvic Renal Ectopia (Pelvic Single Kidney): Case Report. Also a Proposed Classification for Renal Anomalies. Urol. & Cutan. Rev. **44:** 274–277, May 1940.
5. OGDEN, H. D., AND MALTRY, E.: Pelvic Single Kidney; Report of Additional Case. J. Urol. **44:** 13–18, July, 1940.
6. PLANAS, A., AND FABLET, F. J.: Riñón único, ectópico, en pelvis. Semana méd. **2:** 153–156, July 18, 1940.

High-Altitude Joint Pains (Bends): Their Roentgenographic Aspects[1]

SYDNEY F. THOMAS, M.D., and OWEN L. WILLIAMS, M.D.

San Francisco, Calif.

In deep-sea diving the respiratory gases are forced into solution in the body fluids and tissues as a result of increased pressure. When return to the surface is fairly rapid, these gases are present in a supersaturated state, and bubbles frequently form. Extremely small at first, these go through a period of expansion, followed by gradual absorption. Nitrogen gas, being physiologically inert, is most important in causing these bubbles; its inertness results in their slow absorption. Ascent to altitudes of 25,000 feet or higher in aircraft results in a similar supersaturation of dissolved gases, with a tendency to bubble formation. The intense pain of "caisson disease," commonly spoken of as diver's "bends," has its counterpart in aviator's "bends," resulting from exposure to extremely high altitude. The symptoms can readily be elicited by simulated flight in an altitude chamber. Ordinarily the pain disappears at about 25,000 feet during the return to ground-level pressure. It is thought that the "bends" pains are due to expanded extravascular bubbles, as a direct or indirect pressure effect. It has also been suggested that intravascular bubbles may, through ischemia, stimulate the pains of "bends." Symptoms are more frequent and more severe if exercise is engaged in at the high altitude. They are most commonly referred to the joints (1).

With the intent to clarify the etiology of aviator's "bends," we have made a roentgen study of the affected parts in a decompression chamber at altitudes of 35,000 and 38,000 feet, both in the presence and absence of pain. As our work progressed, we learned of work being done by others in the same field and have received many helpful ideas from them.

The first reported roentgen observation of gas in the tissues in "bends" seems to have been by Gordon and Heacock in 1940 (2). A patient who had been working under pressure (25 lb. per sq. inch) suffered fracture of the proximal ends of the tibiae and was "decompressed" rapidly. Study of the published reproductions of the roentgenograms suggests that the authors may have been misled by a lipohemarthrosis. This is not an uncommon occurrence after fracture at this site, and a layer of fat floating on top of blood in the synovial cavity can indeed imitate a bubble of gas.

METHODS

In our studies lateral views of knees were made on non-screen film with a small portable x-ray machine. Often pain was present in only one knee, but films of both knees were made (routinely) for control. Similar films were also made of the subjects at sea level. No extensive studies of the chest or abdomen were attempted.

RESULTS

In every person, whether with or without "bends" pain, gas can be shown in the knee joint at an altitude of about 20,000 feet, increasing to a maximum in about thirty minutes at 30,000 feet.

The demonstration of large volumes of gas (estimated at 50 to 75 c.c.) is clearly seen in Figure 1. Gas in the knee joint, however, is not necessarily associated with pain and may be freely aspirated. It consists of nitrogen, oxygen, and carbon dioxide, approximately in equilibrium with the normal blood gases. It appears also in

[1] From the Aero Medical Unit, University of California, Berkeley, Calif. The work described in this report was done under a contract recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of California, Berkeley, Calif., under the direction of Dr. J. H. Lawrence. Accepted for publication in November 1944.

Fig. 1. Large collection of gas in the synovial space of the knee; more specifically, the suprapatellar bursa. This subject had been at an altitude of 38,000 feet for twenty-eight minutes and had no bends or pain.

periarticular tissues: (*a*) in small irregular collections, (*b*) in small discrete bubbles, (*c*) in streaks along fascial planes and tendons.

CONTROLLED EXPERIMENT

These studies were carried out at 35,000 feet altitude, which was attained at a rate of 5,000 feet per minute. Exercise, consisting of five squats to the "heel-sitting" position, was done every three minutes to increase the speed of appearance of pain in the knee. Films were made only on subjects with knee pain of moderate or greater severity. Films were made of the knee without pain for control purposes.

Most of the films were interpreted twice. A count was made of the number of bubbles that were discrete and found posterior to the femur in the upper popliteal fossa (Fig. 2). The amount of streaking was estimated on a 0 to 3 scale.

Thirty-five observations were made on 27 individual subjects, with the following results:

1. Bubbles with pain, 46; bubbles without pain, 28. Critical ratio 2.4 (barely significant).

2. Streaking with pain, 47; streaking without pain, 15. Critical ratio 3.71 (highly significant).

Fig. 2. A collection of discrete and irregular bubbles (A) is seen posterior to the distal end of the shaft of the femur. Note also the wavy streak of gas which undoubtedly lies in a fascial plane or along a tendon (B). This subject had moderately severe bends. He had been at 35,000 feet for ten minutes, having done three series of deep-knee bending.

3. Total tissue gas (bubbles plus streaking) with pain, 63; without pain, 43. Critical ratio 3.3 (significant).

The critical ratio is a measure of the statistical dependability of a difference, and is defined as the mean difference divided by the standard error of the mean difference. For 27 individuals, a critical ratio of 2.1 is possibly significant, while a ratio of 2.8 or greater is definitely significant.

The results of this analysis indicate that the greater the amount of bubbles or streaking seen in the periarticular tissues, the more likely is "bends" pain to occur.

Both bubbles and streaking may occur in the absence of pain. To our knowledge there is no characteristic roentgenographic picture with which the pain is correlated.

The gas is usually reabsorbed from the soft tissues and joint spaces by the time sea level is reached, although we have seen small (2 mm.) bubbles persist in a few in-

Fig. 3. Collection of gas in the vaginal sheath of the flexor tendon. This was easily palpable and could be milked along the length of the finger. No pain was experienced.

stances for as long as five minutes after return to sea level.

We have not been able to demonstrate free gas in the subarachnoid or subdural spaces at altitude in the presence of pain (2 subjects), even though gas bubbles have been demonstrated in the spinal fluid of animals by Haldane *et al.* (3).

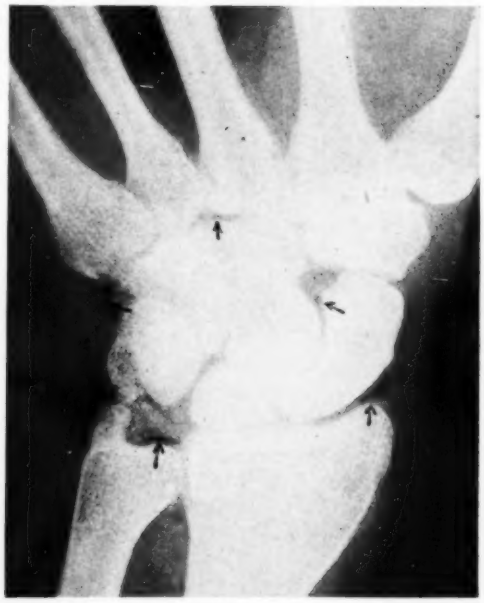

Fig. 4. An example of various foci of gas formation in the wrist, indicated by arrows. This subject had no pain.

Free gas could not be shown in the peritoneal or pleural spaces (3 subjects).

SUMMARY

1. Demonstrable gas is present in the soft tissues and synovial spaces when the body is subjected to decompression, although pain may be absent.

2. Bends pain is more likely to occur when the quantity of periarticular gas is greatest, but no characteristic pattern of gas formation has been recognized in bends.

1019 Hampshire St.
San Francisco, Calif.

REFERENCES

1. BRIDGE, E. V., and others: Decompression Sickness. J. Aviation Med. **15:** 316–327, 1944.

2. GORDON, J. O., AND HEACOCK, C. H.: Roentgenologic Demonstration of Localized Gas in Caisson Disease. J. A. M. A. **114:** 570–571, 1940.

3. BOYCOTT, A. E., DAMANT, G. C. C., AND HALDANE, J. S.: Prevention of Compressed Air Illness. J. Hygiene **8:** 342–456, 1908.

A Contribution to the Treatment of Post-Irradiation Necrosis[1]

JOHN E. MOSELEY, M.D.[2]

New York, N. Y.

THE MANAGEMENT of post-irradiation ulcers is one of the most perplexing problems confronting radiotherapists and dermatologists. Such lesions are usually punched-out ulcers, the walls of which are composed of thick ischemic fibrous tissue. The ulceration itself represents the area of greatest ischemia. Local vascularity is at a minimum, the blood vessels showing marked sclerosis of the intimal, medial, and muscular coats. These tissues, then, are deprived of their normal capacity for growth and repair and therein lies the difficulty of accomplishing the healing of such lesions.

Numerous conservative, non-surgical methods of treating post-irradiation ulcerations have been tried. Among the agents employed are ultraviolet radiation (1), the aloe vera leaf (2), ointment containing pancreatic ferments (3), radium, and an assortment of salves. The results of treatment with these non-surgical methods have not been satisfactory. Conway (4) concludes that conservative measures are of little value in the eradication of necroses following roentgen and radium therapy and that these lesions must be treated by surgical intervention. Surgery, however, must be radical and is often attended by poor cosmetic results. Moreover, not every patient will consent to operation.

In view of these circumstances, the virtues of any other proposed conservative method of treatment should be carefully appraised. Sellers (5) recently reported three cases of "x-ray burns" in which local application of estrogenic hormone in oil yielded excellent results. One of the patients was the author himself. He and one of his patients—both with ulcers of the fingers following overexposure to roentgen rays—had undergone the full gamut of ointment applications, "with but slight avail." After ten months of unsuccessful treatment, estrogenic hormone in oil solution was applied to the crater of the ulcerations three to six times a day. Improvement was noticeable within fifteen days. Subsequently, sesame oil was used as a control without visible results. Finally, after thirty days of continuous application of estrogenic hormone, the lesions healed. In the third patient, with a roentgen-ray ulcer of the left index finger, treatment with estrogenic hormone for two months resulted in complete healing.

Another favorable report along these lines is that of Wagner (6). He treated 7 patients with roentgen-ray ulcers—3 men ranging in age between thirty-five and seventy and 4 women between forty-four and seventy years of age—with an ointment containing synthetic estrogen, applying this locally every day to the resistant lesions. This therapy resulted in 2 cures, while 5 patients were greatly improved. Wagner observed formation of granulation tissue and beginning epithelization under the influence of the hormone ointment.

Encouraged by these reports, particularly the article by Sellers, we decided to place on estrogenic therapy two cases of severe post-irradiation necrosis which were under our care.

CASE I: J. S., a white female, aged 43 years, was referred to us for radiation therapy of a carcinoma of the cervix. Between Oct. 7 and Dec. 7, 1937, she received a total of 3,000 r to each of four pelvic areas, anterior and posterior, right and left. On Dec. 9, 1937, radium was inserted in the cervical canal in a sound containing three 10-mg. tubes; in addition, a colpostat containing three 15-mg. tubes was placed in the vagina adjacent to the cervix. A total of 7,000 mg. hours was applied. In February 1938 each pelvic area was given another 1,000 r.

When the patient was next seen, in December 1939, some telangiectasis had developed over both

[1] From the Radiation Therapy Department (Ira I. Kaplan, Director), Bellevue Hospital, New York City. Accepted for publication in June 1944.

[2] Trainee, National Cancer Institute.

Figs. 1 and 2. Case I. Figure 1 (above) shows post-irradiation lesions on both sides of the lower abdomen. On the left side there is severe telangiectasia; on the right side, a deep ulceration measuring 6.5 × 7.0 cm.

Figure 2 (below) shows unchanged telangiectasia on the untreated left side and completely healed ulcer on the right side following application of estrogenic ointment.

lower abdominal areas, progressing by March 1940 to severe telangiectasia with thickening. In December 1942 the patient noticed a painful ulceration on the right side, in the center of the telangiectatic area. In January 1943 she reported to the clinic, and at that time a deep ulceration, measuring 6.5 × 7.0 cm., was present in the right lower quadrant of the abdomen. The edges of the necrotic area were

Figs. 3 and 4. Case II. Deep post-irradiation ulcer below angle of jaw (left), with complete healing following therapy with estrogenic ointment (right).

sharp and indurated, the skin was thick, and there was severe telangiectasia of the surrounding skin. On the left side there was no ulcer but telangiectasia was severe; the skin was appreciably thickened and board-like (Fig. 1).

A biopsy specimen taken from the edges of the ulcer did not reveal malignant growth. Surgery was advised but was refused. Therefore, on Feb. 2, 1943, treatment with estrogenic ointment was instituted. An amount representing the equivalent of 5,000 I.U. of estrone was applied to the ulcer, no therapy being given to the unulcerated left side. The lesion was then covered with a gauze dressing which had been coated with vaseline to prevent absorption of the estrogenic ointment by the dressing. This procedure was repeated twice a week for one month. At the end of this period the ulcer showed some filling in from below but its width and length were unchanged. It was therefore decided to increase the dose of the estrogenic hormone. The patient was instructed to apply the ointment herself every day (5,000 I.U.) and to report at the clinic twice a week. The "dosules"—individual dose containers—assured exactness of dosage. This technic resulted in steady improvement, and on June 1, 1943, the lesion was completely healed (Fig. 2). On the left side, which had received no therapy, there was no change in the telangiectatic area.

CASE II: J. F., a white male, aged 67 years, was admitted to our clinic in May 1940 with a squamous-cell epithelioma of the tongue with cervical metastases. Between July 19 and Aug. 2, 1940, he received 1,350 r to the right side of the neck, including a palpable submaxillary node, and 1,350 r to the left side of the neck, which also included a metastatic submaxillary node. On Aug. 8, radium in the form of four 60-mm. 2-mg. needles was inserted in the cervical nodes on each side and sixteen 2 mg.-needles were inserted into the tongue lesion. Each side of the neck received a total of 1,152 mg. hours and the tongue received a total of 3,072 mg. hours. The node in the left side of the neck slowly disappeared but the right submaxillary node failed to show much response. On Dec. 5, 1940, another eight 60-mm. 3-mg. needles were inserted on this side, for a total of 2,184 mg. hours. Thus, the right side of the neck received a total of 3,336 mg. hours of radium.

In July 1942, the patient presented a deep ulcer just below the angle of the right jaw. The surrounding skin was extensively telangiectatic and thickened. The ulcer was punched-out in appearance, with thick indurated walls. It had the shape of a triangle, each side measuring approximately 1.5 cm., and was fixed to the underlying tissues. There was a yellow slough in the crater (Fig. 3). A biopsy specimen taken from the edge of the ulcer did not reveal malignant tissue. The lesion was treated with an assortment of ointments until Jan. 4, 1943, when it was decided to institute treatment with estrogenic ointment. An amount representing the

equivalent of 5,000 I.U. of estrone was applied daily to the lesion and a protective coating of vaseline gauze dressing was placed over the ointment. The ulcer began to fill in from the bottom two months after initiation of treatment and by Aug. 30, 1943, was completely healed (Fig. 4).

DISCUSSION

The factors probably accounting for the gratifying results attending the use of estrogenic ointment in these two cases of post-irradiation necrosis are the vasodilating effect of follicular hormone upon the smallest blood vessels of the skin and its selective growth-promoting action.

Experimenting in normal adult males, S. R. M. Reynolds and F. I. Foster (7) studied the peripheral vascular effect of estrogens. Two-thirds of their 20 subjects showed an increase in finger volume following administration of a preparation in which estrone predominated (two of the men were treated with a stilbestrol preparation instead). This volume increase, lasting from half an hour to an hour, is dependent on dilatation of the small vessels of the skin beyond the arterioles. The same authors (8) found that estrogens will dilate the smallest blood vessels of the rabbit's ear. Reynolds and Foster with their associates (9) also measured the dermovascular effects of estrogen on women in the menopause. The response, characterized by an increase in finger volume, is held to be the result of vasodilatation of the smallest vessels distal to the arterioles.

Impaired circulation is one of the etiologic factors in failure of a chronic ulcer to heal. Thus, by exerting a vasodilative effect on the small vessels of the tissues surrounding the lesion, estrogens enhance the blood supply of the adjacent parts with ensuing acceleration of the repair process.

Another salutary effect of estrogen may lie in its potential growth-promoting effect on granulation and epithelial tissue. It has long been known that estrogens are, in a way, growth substances, affecting, for example, uterus, vagina, fallopian tubes, external genitalia, and breasts. The hormone not only promotes the growth of these organs but also causes changes in the epithelium of the vagina, cervix, and uterus. The application of the estrogenic hormone in gonorrheal vaginitis in children, in senile vaginitis, and in vaginal hypoplasia is predicated on its induction of cellular proliferation. The rationale for estrogen administration in ulcerative cervicitis is the same. While it is not within the scope of this presentation to prove the induction of such cellular proliferation by estrogen in the ulcer cases reported, the possibility of such an action outside of the reproductive tract should be kept in mind.

SUMMARY

Two severe cases of post-irradiation necrosis are presented, in which the application of an estrogenic ointment brought about complete healing of the ulcers. A possible rationale for such therapy is briefly discussed.

ACKNOWLEDGMENT: The estrogenic ointment used in this study was Menformon Dosules generously supplied by Roche-Organon, Inc., Nutley, N. J., through the curtesy of Dr. Leo Pirk.

222 W. 138 St.
New York, N. Y.

REFERENCES

1. BRUNER, E.: Zur Behandlung der Röntgenulcerationen der Haut. Strahlentherapie **36:** 373–384, 1930.
2. MANDEVILLE, F. B.: Aloe Vera in Treatment of Radiation Ulcers of Mucous Membranes. Radiology **32:** 598–599, May 1939.
3. SCHWEITZER, A.: External Application of Pancreas Hormone in Dermatology with Special Reference to Treatment of Ulcus Cruris and Roentgen Ulcer. Urol. & Cutan. Rev. **40:** 333–335, May 1936.
4. CONWAY, H.: Surgical Management of Post-radiation Scars and Ulcers. Surgery **10:** 64–84, July 1941.
5. SELLERS, C. W.: Estrogenic Hormone for X-Ray Burns. J. Michigan M. Soc. **41:** 59, January 1942.
6. WAGNER, D.: Über die Lokalbehandlung chronischer Hautulcera mit Oestrostilbenen. Arch. f. Dermat. u. Syph. **181:** 395–403, 1940.
7. REYNOLDS, S. R. M., AND FOSTER, F. I.: Peripheral Vascular Action of Estrogen in Human Male. J. Clin. Investigation **18:** 649–655, November 1939.
8. REYNOLDS, S. R. M., AND FOSTER, F. I.: Peripheral Vascular Action of Estrogen, Observed in Ear of Rabbit. J. Pharmacol. & Exper. Therap. **68:** 173–184, January 1940.
9. REYNOLDS, S. R. M., KAMINESTER, S., FOSTER, F. I., AND SCHLOSS, S.: Dermovascular Effects of Estrogen in Women with Menopausal Flushes. Surg., Gynec. & Obst. **73:** 206–211, August 1941.

Radiology vs. the Monsoon: Effect of Climate upon Equipment[1]

LT. COL. PHILIP J. HODES, M.C., A.U.S., and 1ST. LT. GEORGE P. KEEFER, M.C., A.U.S.

THE PRESENT communication is intended for those who are interested in the physical and technical aspects of radiology. Radiologists whose concern in their specialty is purely medical need read no further, for it is our purpose to discuss the behavior of x-ray equipment exposed to unusual climatic conditions.

Before presenting our experiences, it seems fair to state that the apparatus used in our department was not meant for operation in a monsoon area alone. The global aspects of World War II made it necessary to employ the same equipment under climatic conditions of all sorts. Nevertheless, these machines have given excellent service no matter where used.

The wide variations in the humidity and temperature in India produced defects and failures in our equipment which we believe are worth recording. Whereas none of these "breakdowns" was considered a major problem, they did cause trouble and had to be recognized and rectified. It is with the hope that our experiences may help others working in a similar climate that these difficulties have been reviewed and are presented here.

The yearly rainfall in that part of India in which our hospital was located averaged about 120 inches. Most of this precipitation occurred during June, July, August, and September, when the monsoon was at its height. April, May, and October were also wet but with much longer rain-free intervals.

The humidity varied between 85 and 100 per cent during the monsoon. Whereas during the rest of the year the figure was not so high, it frequently remained above 80 per cent. During November, December, January, and February, at about five o'clock in the afternoon a heavy fog settled over the valley in which we were situated and did not lift until eight o'clock the next morning. During these months, however, the middle of the day was usually dry. The temperature in the shade varied from a low of about 55° during the winter months to about 95° during the monsoon.

In summary, the weather in the environs of our hospital was damp or wet most of the time, uncomfortably hot about half of the time, and very dry about one-quarter of the time.

EFFECT UPON X-RAY FILM

While we were aware of the untoward effects of heat and humidity upon unexposed x-ray films, we were surprised to find serious fogging of untropically packed films six to nine months before the film expiration date was reached. This was not true of tropically packed film, which in most instances remained in excellent condition. But, whereas films thus packed in metal containers remained in better condition than those delivered in paraffin-soaked cardboard boxes, we felt that the added expense[2] of the metal containers used for tropical packing was not justified if the films were to be used before the expiration date and the cardboard boxes were not damaged. When tropically packed films manufactured by the same company were examined at the end of the same expiration period, little gross difference was observed between the quality of those packed in metal containers and those sealed in paraffin. On the other hand, considerable difference existed between tropically packed films prepared by different companies. Indeed, the film of some manufacturers could not be used even though it had been tropically packed and the expiration date was not exceeded.

An extremely common nuisance in various localities in India was mold (Fig. 1). Unless precautions were taken, photographic and x-ray films were rapidly

[1] Accepted for publication in June 1944.

[2] We assumed that the metal containers were more expensive although we were unable to obtain price comparisons.

covered with its scum-like patches. It developed much more commonly after the films had been exposed and processed, probably due to removal of the protective wrapping material. The mold appeared as irregularly shaped gray or greenish patches which spread rapidly across the surface of the film, disfiguring it within a few days. Whereas rapid drying and the use of some type of container in which the films could be enclosed delayed the process for weeks, within several months the mold frequently began to develop around the edges of the film.

Various procedures have been advised to prevent film from becoming moldy. We found it most expedient to use a solution of 5 per cent formaldehyde in which the completely processed film was immersed for one minute, after which it was allowed to dry slowly in the air. The film thus partially dried was then *completely dried* in the regular army field dryer, a procedure which we believe was of paramount importance in preventing mold. Ordinary care was observed at all times to keep dirt from settling upon the films until they were stored. While not 100 per cent effective, these precautions prevented the growth of mold almost entirely.

Fig. 1. Mold on a roentgenogram. This film, about nine months old, was not immersed in 5 per cent formaldehyde when processed. The mold colonies are represented by the small gray patches.

FILM PROCESSING

When the Radiological Department first began to operate, freshly prepared developing and fixing solutions ready for use were available. When these chemicals became exhausted, a new stock was prepared with tap water, as there was no distilled water available for making solutions. The solutions were prepared in enamelware buckets at proper temperature by a technician who had specialized in film processing in civilian life. The chemicals dissolved completely and the solutions were allowed to stand twenty-four hours before use.

When adequately exposed films were processed in these freshly made solutions, the images were barely perceptible. It was obvious that something was wrong with the developing solution. A second container of developer was then prepared, with the same water, with the same result. The image was barely distinguishable after the film had been fixed. Apparently the reducing agents in the developer were exhausted by some substance in the water. It was believed that the chlorine used in the hospital water supply was to blame.

Since we had no distilled water and no facilities for collecting rain water, river water was obtained, which was boiled and filtered. The developing solution made from this water was also exhausted before it was used.

A third water supply was then tapped, a well at some distance from the hospital. The solutions made with this water behaved normally, and we continued to use it until the hospital water supply was changed, following which we encountered no difficulty with our solutions even though chlorine was still used.

The indications were that the original water supply contained enough organic and inorganic waste to exhaust the reduc-

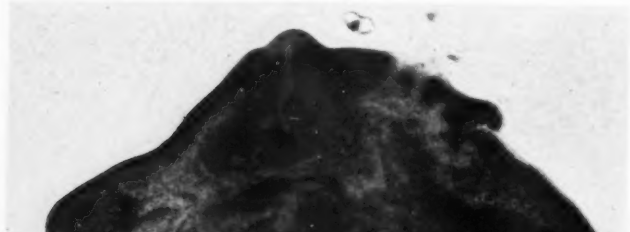

Fig. 2. Fixing solution scum, scraped from the top of a freshly made 10-gallon container of fixing solution. It had the consistency and color of chocolate ice cream. It represented about 6 ounces of debris.

Fig. 3. Cassette storage bin made of wood, with two 25-watt bulbs in the bottom. Note slots for 14 × 17-inch cassettes within the box. Smaller cassettes and fluoroscopic screens were stored in a second bin of similar construction.

ing properties of the elon and hydroquinone contained in the developer. This water was drawn from a river swollen by the monsoon and extremely turbid, in which dead animals could be seen floating constantly. Whereas the new water supply to the hospital came from the same source and contained chlorine, we had no further difficulty with processing solutions, probably as a result of the filtration and the addition of settling tanks to the water system.

In spite of filtration and settling tanks, however, enough silt still remained in the water to clog surface drains and collect as a sediment in the processing tanks. In pre-

paring fixing solutions the silt formed a mud-like scum on the surface, which had to be carefully removed (Fig. 2). Unless this was done, the silt was deposited upon the film in appreciable quantities. The dirt in the developing solution settled to the bottom of the container, from which it was scraped and washed whenever new developer was prepared.

Constant vigilance was necessary to prevent sweat from marring films and cassette screens. Perspiration from the hands and forearms was particularly difficult to control. Once dropped upon screen or film emulsion, its imprint could not be entirely eradicated. The most serious damage occurred in cassettes, where moisture made the film emulsion stick to the emulsion of the screen. This frequently resulted in permanent scarring of the screen emulsion. To prevent this, our technicians were trained to open cassettes just a few inches, thereby minimizing screen damage while removing films and reloading cassettes.

CASSETTES

Standard bakelite-faced cassettes of the type seen in the United States were used during the past year. Whereas little difficulty in maintaining good screen contact was experienced in the 8 × 10- and 10 × 12-inch cassettes, the 14 × 17-inch screens required remounting. Practically every pair of screens in the 14 × 17-inch cassettes was remounted at least twice because of bulging of the bakelite face. In some instances the screens were remounted three or four times during the year. In spite of these efforts, screen contact remained poor in about one-half of the 14 × 17-inch cassettes, and several had to be discarded.

The effect of the monsoon upon the cassettes would have been much worse had not some attempt been made to protect them. Due to the lack of dehydrating substances, the cassettes were stored in an electrically heated wooden box (Fig. 3). Two 25-watt bulbs placed in the bottom of this well ventilated box served the purpose to some degree of satisfaction.

Fig. 4. Intensifying screen in cassette, showing blisters in screen emulsion which had broken open (*A*) and an intact bleb with its surface unbroken (*B*).

Not infrequently small blisters developed on the surface of the screens. These thin blebs varied considerably in size, the largest being several centimeters in diameter and about 2 mm. thick (Fig. 4). Their surface was thin and seemed to blend with the surrounding emulsion. Whether these blisters were due to droplets of sweat or humidity alone was never determined.

MOVABLE POTTER-BUCKY DIAPHRAGMS AND WAFER GRIDS

Potter-Bucky diaphragms and wafer grids were of standard construction with bakelite (or composition?) surfaces and strip metal edges. They fared no better than the cassettes in the local heat and humidity. One Potter-Bucky diaphragm swelled so badly that it stuck in its housing and could not be moved. When the bakelite and the metal frame were removed,

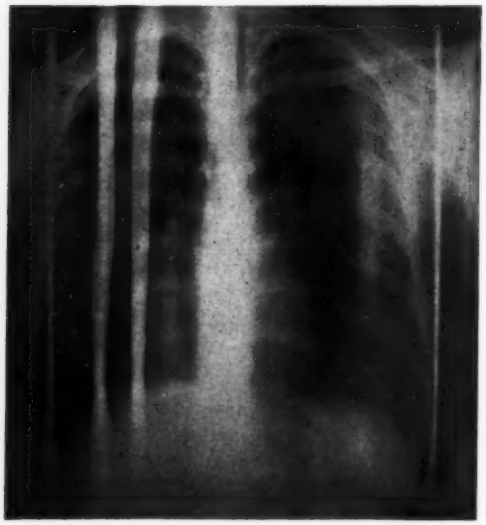

Fig. 5. Test film of wafer grid. Roentgenogram of chest made with wafer grid exposed to monsoon for six months.

1/4- to 1/2-inch ripples immediately appeared in the lead laminated grid. This grid was discarded.

Of the two 14 × 17-inch wafer grids, one was discarded in six months because of distortion. Its lead laminations became twisted and interfered with proper radiography (Fig. 5). Whether the flat sheets of composition material buckled first, allowing the grid itself to warp, or whether the grid was primarily to blame could not be definitely determined. It seemed that, as a result of the heat and humidity, the two flat sheets of composition material buckled first, thereby allowing the grid to change its shape. Indeed, buckling of the flat composition sheets was enough to leave a gap of 1/4 inch between its fitted margins and the metal stripping which held the grid together (Fig. 7). Part of this gap was due to actual bowing of the metal strips themselves, the two strips lying parallel to the lead laminations being the only ones affected. The metal strips lying perpendicular to the lead laminations remained perfectly straight.

We felt that the grid itself also suffered as the result of the climate, in spite of the shellac, varnish, or other substances with which it was painted by the manufacturer.

FLUOROSCOPIC SCREENS

Of three fluoroscopic screens, none tolerated the monsoon. All warped and revealed a wavy appearance with at least five or six crests and troughs across the surface (Fig. 6). The lead glass covering the face of the screen was unaffected. The bakelite back of the screen, however, was definitely buckled and had a "give" to it when pressed against the lead glass.

Fig. 6. Fluoroscopic screen showing wavy appearance under the lead glass. Patches of color resembling Newton's rings were seen in indirect sunlight at the crest of the waves. The shape of the waves was changed by pressure upon the bakelite back of the screen.

These changes were unquestionably due to moisture. When the lead-glass surface was observed in indirect sunlight, many irregular iridescent patches of color could be seen along the crests of the wavy screen which were in contact with the inner surface of the glass. These looked exactly like Newton's rings. The size, shape, and position of these Newton's ring-like patches were easily affected by pressure against the warped bakelite back of the screen, which brought different surfaces of the emulsion in contact with the lead glass.

Finally, we had the distinct impression that the quality of the fluoroscopic image

seen upon these screens had also been adversely affected. The luminescence of the screen seemed less intense and the images less distinct. Unfortunately we had no means to prove this.

SHOCK-PROOF CABLES

Of the eight shock-proof cables used during the past year, four broke down. All the failures developed at the cable terminals, where moisture probably collected in spite of weekly applications of the prescribed special vaseline. Definite charring was demonstrated in the composition around the ends of the cables and in the tube and transformer housings into which the cable terminals were inserted and had shorted (Fig. 8). Whether this was due to moisture alone or to fluctuations in the primary power supply with high inverses on self-rectified equipment was never determined. Both probably were factors in the cable failures. It was noteworthy that the cables were not punctured near the center; the failures occurred at the cable insertions.

DISCUSSION

The importance of protecting x-ray equipment and accessories from heat and humidity cannot be overemphasized. Radiologists in this theater of war were not alone in their difficulties. Similar electrical and structural annoyances were habitual wherever electrical equipment was employed, unless the apparatus had been built especially for a monsoon area.

Corrosion caused no end of trouble and had to be constantly combated by scraping, sandpapering, and repainting, in spite of the fact that thin films of oil were applied to exposed surfaces several times a week. Contactors, switches, rheostats, meters, and viewing boxes all were troublesome at some time or other due to the climate. Of all substances, stainless steel withstood the rigors of the monsoon best. The painted metallic surfaces of the x-ray machines also stood up satisfactorily except at corners from which paint had been chipped or where pieces of metal had been imperfectly welded. Rubber covering for cables of all types retained its texture and

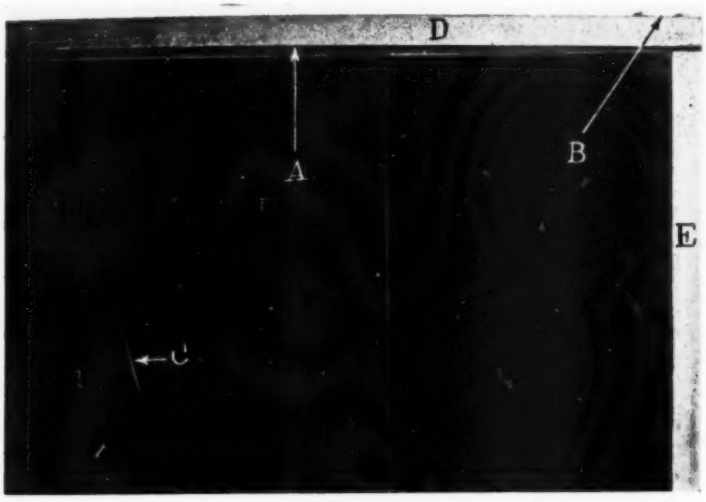

Fig. 7. Corner of wafer grid. Note how the strip metal edge, *D*, bowed and the bakelite sheeting buckled to form the defect at *A*. Metal edge *D* was parallel to the lead laminations in the grid. Metal edge *E*, which was perpendicular to the lead laminations, remained perfectly straight. Two screws in the corner of the grid designated by *B* became loose and had to be replaced by other screws, the caps of which are barely visible. *C* is a film defect.

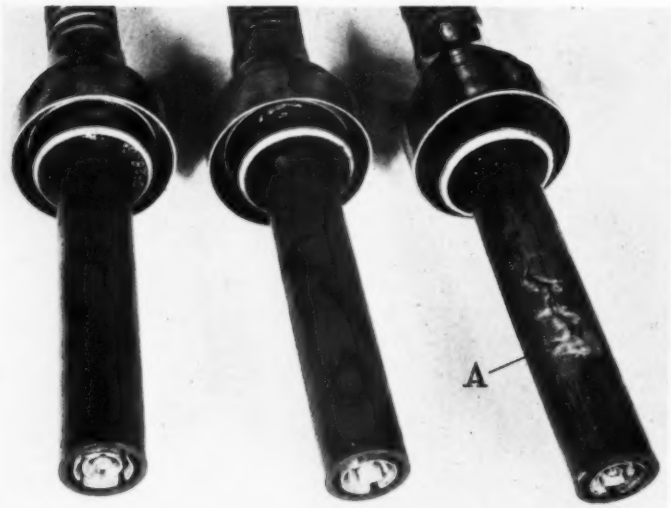

Fig. 8. Shock-proof cables, showing characteristic scarring with charred irregular crevices. At *A*, the insulating composition was scraped with a knife to reveal the depth of the charred portion in the insulator. (Dirt in the end of the latter terminal was picked up after the cable had failed.)

protective qualities. At the end of one year lead rubber showed no unusual deterioration.

It was our good fortune to have a visitor who had spent over fifteen years installing and repairing x-ray equipment in this part of the world and in other countries where the monsoon is a constant threat. We were grateful to learn that ours was not a unique experience. He had met the same difficulties in other installations even less exposed to heat and moisture than we were.

In some respects radiological departments serving our Armed Forces outside of the continental United States have acted as "proving grounds" for x-ray equipment. Unfortunately we did not possess the technical skill to take full advantage of our opportunity to study thoroughly the behavior of x-ray equipment exposed to heat and humidity. Nevertheless, we learned enough during the past year to convince us that the efficiency and durability of x-ray equipment used in temperate climates could be enhanced by rectifying the deficiencies observed in our "proving ground" in India.

SUMMARY

1. We have reviewed our experiences with x-ray equipment exposed to unusual heat and humidity for approximately one year.

2. We have recorded and illustrated the difficulties encountered in the hope that others working in a similar climate may find them helpful.

3. Most of the disorders seem remediable. Corrective measures may prolong the life and enhance the efficiency of x-ray equipment used in temperate climates.

NOTE: The photographs reproduced in this paper were made by the Museum and Medical Arts Service, Army Medical Museum.

Depth Dose Measurements at 400 Kilovolts[1]

LILLIAN E. JACOBSON

Physicist, Montefiore Hospital, New York

IT IS THE PURPOSE of this paper to give the results of depth dose measurements on a 400-kv. machine. Because of the difficulty in making measurements in water, with a removable chamber, the depth doses were measured in a Masonite pressdwood phantom.

Pressdwood is not "standard" and may vary in density and composition. It is therefore advisable to compare the particular sample with water before beginning a series of measurements. A comparison was made between the depth doses in our sample of pressdwood and water, using the same ionization chamber in each, at 100 kv., hvl. 1.86 mm. Al, 200 kv., and 400 kv. The depth doses agreed to within about 5 per cent. Since this obtains, this pressdwood phantom can be used for depth dose measurements instead of water at the above voltages.

TABLE I: DEPTH DOSAGE TABLE FOR 400-KV. ROENTGEN RAYS (HVL. 4 MM. CU), FOR FIELDS OF 25, 50, 100 AND 200 SQ. CM.

Depth	60 cm. F.S.D.				70 cm. F.S.D.				80 cm. F.S.D.			
	25 sq. cm.	50 sq. cm.	100 sq. cm.	200 sq. cm.	25 sq. cm.	50 sq. cm.	100 sq. cm.	200 sq. cm.	25 sq. cm.	50 sq. cm.	100 sq. cm.	200 sq. cm.
	Per Cent of Surface Dose											
5 cm.	60	64	67	71.5	64.5	68.5	72	75.5	65.5	70	73	76.5
6	51	55.5	59	65	54.5	59	64	68	55.5	59	64.6	70.5
7	44	48.5	52	58.5	46.5	51.2	56.7	61	47.5	50.7	57.5	64.5
8	38	42.5	46	52.5	40	45	50.2	54.5	40.5	44	51	58.8
9	33	36.7	40.5	47.2	34.5	39.3	44.5	48.7	35	39	45.5	53
10	28.5	32	36	42.5	29.8	34.5	39.5	43.5	30.5	34.2	40.3	47.5
15	13.5	15.5	20	24.5	14.5	18.5	21.5	25	15.2	19.3	22.3	27
20	6.5	7.5	10.5	13.5	7.2	10	11.7	14.2	7.7	10.8	12	15
Exit 25	3	4	5	7	3.7	4.5	6	7	4	5.3	6.3	8

EXPERIMENTAL WORK

Measurements were made with a Victoreen condenser dosimeter, removable type ionization chamber. The phantom was made of Masonite pressdwood, each board having a thickness of 0.373 cm. and measuring 30 × 30 cm. The density of the material was about 1.05 gm./c.c. The phantom was always 25 cm. thick.

A group of six boards was drilled so that the ionization chamber fitted snugly into them. These six boards were divided into two sets. In one set the chamber rested; the other set covered the chamber. These two sets will be called the chamber boards. The surface measurements were made with the ionization chamber half "submerged" in one set of chamber boards in the same manner as surface measurements are made for water. At other depths, measurements were made with the chamber snugly encased in the chamber boards at definite distances from the surface. Measurements were reproducible. The water phantom used for comparisons had the same dimensions as the pressdwood phantom.

The radiation from the 400-kv. machine had a half-value layer of 4 mm. Cu when a 2 mm. Cu + 1 mm. Al filter was added. The size of the field was obtained by means of an Oddman light box, which gave the outline and center of the field and also indicated the distance. The adjustable diaphragm at the bottom of the box was located at 53 cm. from the target.

The roentgen rays from the 200-kv.

[1] Accepted for publication in May 1944.

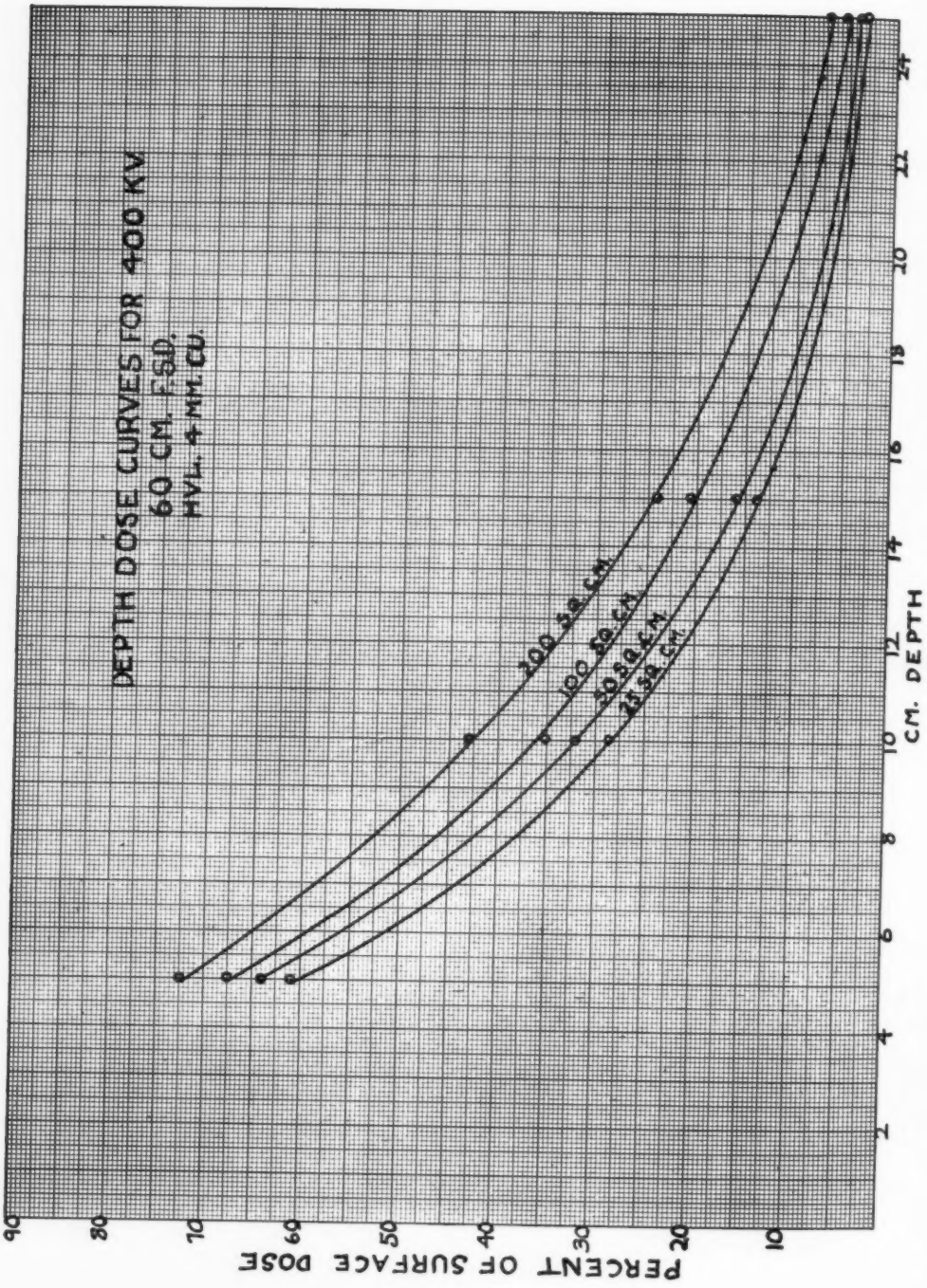
DEPTH DOSE CURVES FOR 400 KV
60 CM. F.S.D.
HVL. 4 MM. CU.
100 sq. cm.
100 50 cm.
20 sq. cm.
10 sq. cm.
PERCENT OF SURFACE DOSE
CM. DEPTH

Fig. 1.

TABLE II: COMPARISON OF DEPTH DOSES FOR 400 KV., HVL. 4 MM. CU WITH 200 KV., HVL. 2 MM. CU, AT 80 CM. F.S.D.

Depth	4 cm. × 5 cm.	5 cm. × 5 cm.	10 cm. × 10 cm.	
	200 kv.	400 kv.	200 kv.	400 kv.
5 cm.	57	65.5	70	73
7	39	47.5	54.5	57.5
10	23	30.5	37	40
15	10	15.2	18.8	22.3

machine had a half-value layer of 2.2 mm. Cu. The fields were outlined by means of cones coming down to the surface of the phantom. The limiting diaphragm was 26 cm. from the target on top of the cone.

Table II. The gain in depth dose for the smaller field is apparent.

Comparison of Depth Doses Obtained by Different Investigators: The depth doses for 400 kv., for half-value layers ranging from 3.5 mm. Cu to 6 mm. Cu, as given directly or extrapolated for the specified distance, are tabulated in Table III. Where there are no numerical superscripts, the figures were obtained directly from curves or tables published by the indicated investigator. In the other cases the figures were obtained by using the inverse-square law to change from a F.S.D.

TABLE III: COMPARISON OF DEPTH DOSES FOR DIFFERENT INVESTIGATORS AT 70 CM. AND 80 CM. F.S.D. AND DIFFERENT FIELD SIZES

	hvl. in mm. Cu	70 cm. F.S.D.						80 cm. F.S.D.					
		25 sq. cm.		100 sq. cm.		200 sq. cm.		25 sq. cm.		100 sq. cm.		200 sq. cm.	
		5 cm. depth	10 cm. depth	5 cm. depth	10 cm depth	5 cm. depth	10 cm. depth	5 cm. depth	10 cm. depth	5 cm. depth	10 cm. depth	5 cm. depth	10 cm. depth
Jacobson	4	64.5	29.8	72	39.5	75.5	43.5	65.5	30.5	73	40	76.5	47.5
Reinhard and Goltz	(0.06 A°)	60	30	72	41	71	42[4]	...	...	...	...	...	...
Meredith and Stephenson	6.32	58	31.6[1]	69	42.5[3]	71	46	...	...	...	...	...	...
Mayneord and Lamerton	4	57.5	30.3[2]	71	42.5	75	49.1	57.4	30.2[6]	70.6	42	75	48.6
Glasser	3.6–5.2	...	...	...	...	...	...	...	...	...	43	...	47
Corrigan	.....	...	...	...	...	80.5	52[5]	...	...	...	...	...	...

[1] Extrapolated by inverse square law from 50 cm. F.S.D. This depth dose is for a 20 sq. cm. field.
[2] 20 sq. cm. field extrapolated from 60 cm. F.S.D.
[3] Extrapolated from 50 cm. F.S.D.
[4] These values are for a 400 sq. cm. field, not reduced to 200 sq. cm. for lack of a conversion factor.
[5] These values are for a 400 sq. cm. field. Extrapolated from 60 cm. F.S.D.
[6] These values are for a 20 sq. cm. field.

RESULTS FOR PRESSDWOOD

The depth doses obtained by using the Masonite pressdwood phantom, density 1.05 gm./c.c., are plotted for 400 kv. and 60, 70, and 80 cm. F.S.D. for fields of different sizes in Figures 1, 2, and 3. Since it is sometimes more convenient to use tables, Table I has been compiled on the basis of the curves.

Comparison of 400-kv. and 200-kv. X-Rays in Pressdwood: The depth doses for 200 kv. were measured for fields 4 × 5 cm. and 10 × 10 cm., at 80 cm. F.S.D. These curves are plotted in Figure 3, which shows, also the doses with 400 kv. for the same distance. The results are tabulated in

of 60 cm. to 70 cm. No correction was made when a field of 400 sq. cm. was compared with a 200 sq. cm. field, for lack of an adequate conversion factor.

The density of the pressdwood phantoms used by other investigators was not always given. Meredith and Stephenson used pressdwood of a density of 1.08 gm./c.c. Glasser used purple heart wood, the density of which closely approximates that of water. The values given by Mayneord and Lamerton are averages of depth dose data of a number of investigators.

Considering the possible differences in phantoms, density of material, diaphragming, and set-ups, it is encouraging to find

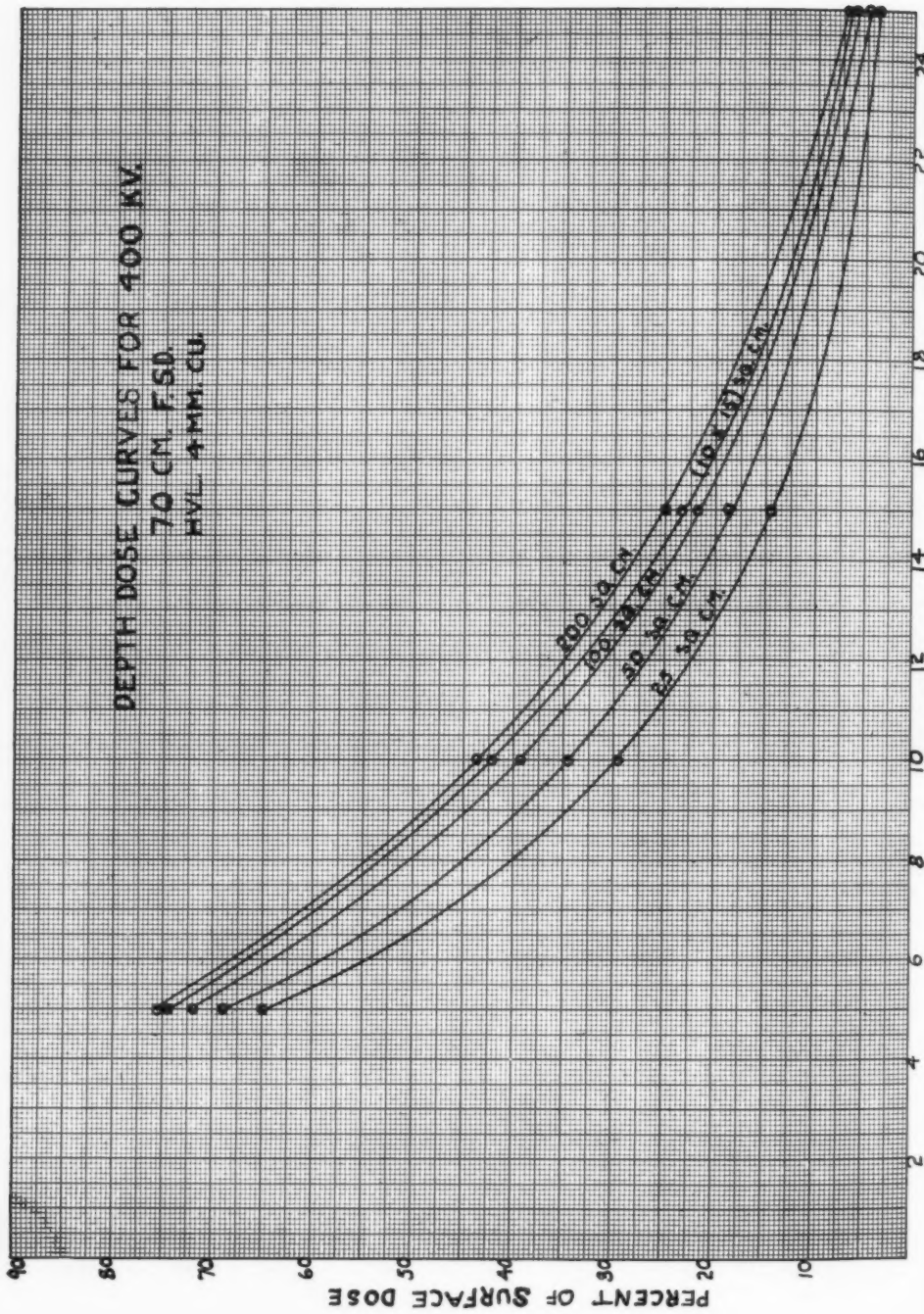
DEPTH DOSE CURVES FOR 400 KV.
70 CM. F.S.D.
HVL. 4 MM. Cu.
200 sq. cm.
100 sq. cm.
50 sq. cm.
25 sq. cm.
PERCENT OF SURFACE DOSE
CM. DEPTH

Fig. 2.

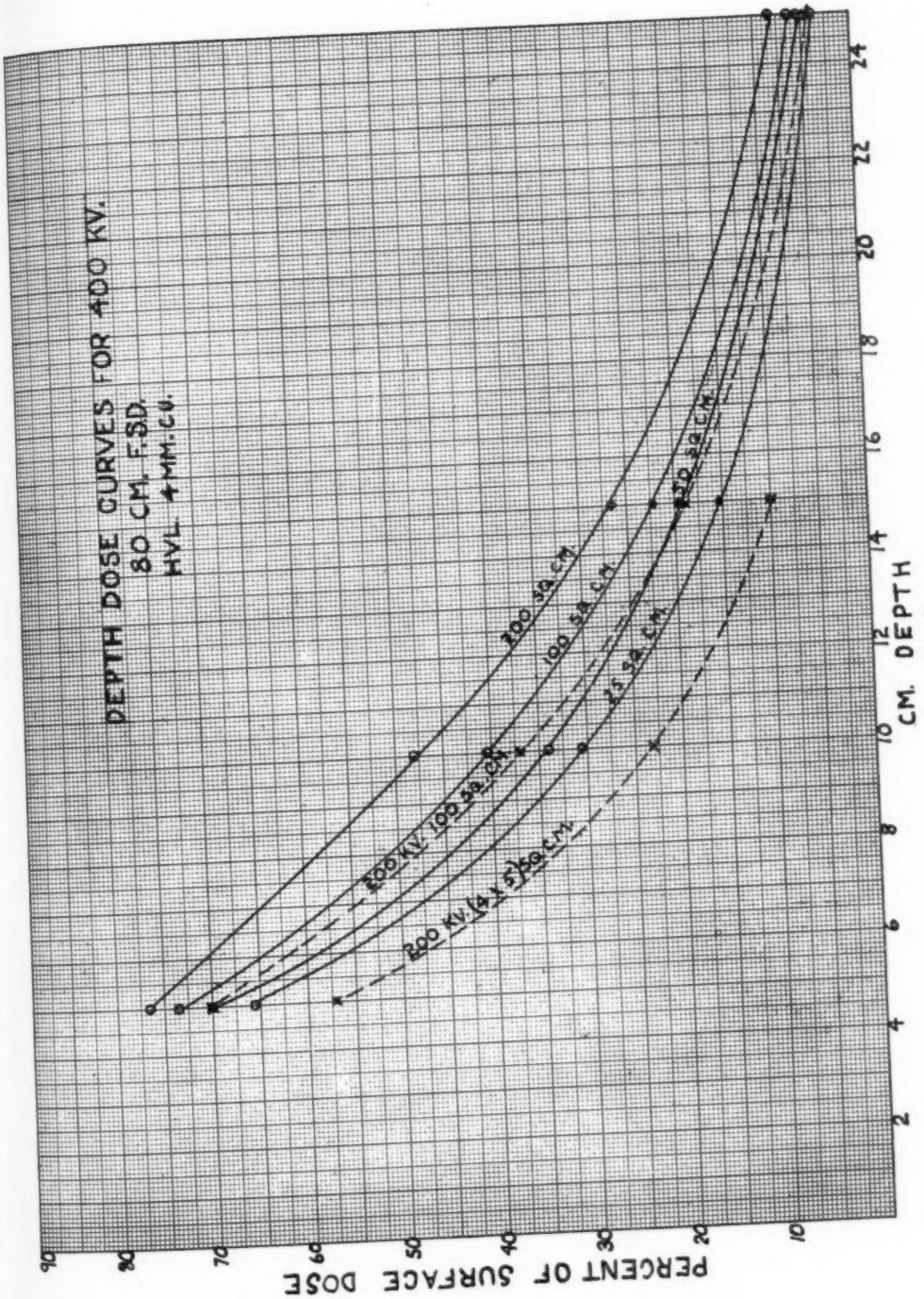
DEPTH DOSE CURVES FOR 400 KV.
80 CM. F.S.D.
HVL 4 MM. Cu.
200 KV. 100 58 CM.
200 KV. 14.5 58 CM.
PERCENT OF SURFACE DOSE
CM. DEPTH

Fig. 3.

that the agreement at a depth of 10 cm. is good.

The 5-cm. depth doses do not agree so well, but this is to be expected. Different sizes of ionization chambers and slight differences in the depth distance at 5 cm. may account for most of the discrepancies.

DISCUSSION

The values for depth doses given in this paper are about the average of those of the other investigators. The question arises as to how well the measurements in pressdwood at 400 kv. duplicate body measurements. If the depth doses for the sample of pressdwood employed are approximately the same as for water, it is permissible to assume that they correspond to tissue measurements.

Spiers (23) believes that, despite the difficulties of measuring in water, it is the most satisfactory medium. He finds that some pressdwoods agree with water reasonably well for wave lengths shorter than 0.2 A.°, which obtains, of course, at 400 kv. The ideal material, other than water, which will parallel tissue absorption for different voltages and be standard, reproducible, and convenient has yet to be found. Perhaps some of the plastics or a "standard" pressed material may be so used.

SUMMARY

1. Curves and tables showing depth doses for 400 kv., hvl. 4 mm. Cu, in a pressdwood phantom of 1.05 gm./c.c. density, are given for different fields.

2. Curves showing depth doses obtained in the same manner for 200 kv. are plotted on the same graph for comparison with 400 kv.

3. A table showing the data obtained by different investigators for depth doses at 400 kv. is given.

Montefiore Hospital
Gun Hill Road, New York, N Y.

REFERENCES

1. CASSEN, B., CORRIGAN, K. E., AND HAYDEN, H. S.: Attenuation and Transition Effects in the Absorption of Supervoltage Radiation. Radiology **31:** 319–324, September 1938.

2. CORRIGAN, K. E.: Physical Factors Influencing the Difference between 200 and 500 Kilovolt Radiation. Radiology **34:** 8–12, January 1940.

3. DRESSER, R., RUDE, J. C., AND COSMAN, B. J.: Differences between 200 Kilovolt and Supervoltage Roentgen Therapy. Radiology **34:** 13–16, January 1940.

4. GLASSER, O.: Dosage Measurements on Ten 400 kv. Roentgen-Ray Generators. Am. J. Roentgenol. **38:** 769–772, November 1937.

5. HARVEY, R. A., DRESSER, R., AND WARREN, S. L.: Physiological Effects of Radiation. III. Lethal Effect of Roentgen Radiation Produced by Various Kilovoltages (50 to 1,000 kv.) upon the Brown-Pearce Rabbit Epithelioma. Am. J. Roentgenol., **42:** 110–121, July 1939.

6. DEN HOED, D., HOUWEN, U., AND KWIESER, M.: "Supervoltage" Roentgen Installation in the Antoni van Leeuwenhoekhuis at Amsterdam. Physical Measurements. Acta radiol. **21:** 583–590, 1940.

7. DEN HOED, D., AND STOEL, G.: "Supervoltage" Roentgen Installation in the Antoni van Leeuwenhoekhuis at Amsterdam. Action of Ultra-Hard Roentgen Rays on Drosophila Eggs. Acta radiol. **21:** 591–596, 1940.

8. LAURITSEN, C. C.: Energy Considerations in High Voltage Therapy. Am. J. Roentgenol. **30:** 380–387, September 1933.

9. LAURITSEN, C. C.: Development of High Voltage X-Ray Tubes at the California Institute of Technology. Radiology **31:** 354–361, September 1938.

10. LEUCUTIA, T.: Comparative Clinical Value of Supervoltage Roentgen Therapy, with Case Reports. Am. J. Roentgenol. **36:** 350–365, September 1936.

11. MAYNEORD, W. V.: Physical Basis of the Biological Effects of High Voltage Radiations. Proc. Roy. Soc., London (ser. A) **146:** 867–879, 1934.

12. MAYNEORD, W. V., AND LAMERTON, L. F.: A Survey of Depth Dose Data. Brit. J. Radiol. **14:** 255–264, August 1941.

13. MAYNEORD, W. V., AND ROBERTS, J. E.: Measurements of High Voltage X-Rays. Brit. J. Radiol. **6:** 321–344, June 1933.

14. MEREDITH, W. J., AND STEPHENSON, S. K.: Some Physical Measurements with a 500 kv. Continuously Evacuated X-Ray Tube. Brit. J. Radiol. **16:** 239–241, August 1943.

15. PACKARD, C.: Biological Measurement of High Voltage Radiations. Radiology **34:** 17–23, January 1940.

16. PARKER, H. M.: Dependence of Back-Scattering of Roentgen Rays in Phantom on Focal Distance, Quality of Radiation and Field Size. Acta radiol. **16:** 705–715, 1935.

17. PHILLIPS, R., AND INNES, G. S.: Physical Measurements in High Voltage X-Ray Therapy. Brit. J. Radiol. **11:** 498–503, July 1938.

18. QUIMBY, E. H., AND ARNESON, A. N.: Comparison of Paraffin and Water Phantoms for Roentgen-Ray Depth Dose Measurements. Am. J. Roentgenol. **37:** 93–97, January 1937.

19. RANDALL, C. L.: Effect upon the Percentage Depth Intensity of Increase in Voltage, Filtration and Skin-Target Distance (150–300 kv. Peak). Am. J. Roentgenol. **38:** 903–914, December 1937.

20. REINHARD, M. C., AND GOLTZ, H. L.: Comparative Isodose Charts for 200 kv., 400 kv., and 1,000 kv. X-Rays. Radiology **38:** 74–76, January 1942.

21. SOILAND, A.: Clinical Observations in the Use of Supervoltage Roentgen Rays, Based upon Six Years' Experience. Am. J. Roentgenol. **40:** 52–62, July 1938.

22. STONE, R. S.: Skin Reactions Caused by 1,000 Kilovolt and 200 Kilovolt Radiations. Radiology **30:** 88–93, January 1938.

23. SPIERS, F. W.: Materials for Depth Dose Measurement. Brit. J. Radiol. **16:** 90–97, March 1943.
24. TRUEBLOOD, H. C., AND LOUGHRIDGE, D. H.: Scattering and Photo-Electric Absorption of High Voltage X-Rays in Nitrogen. Physical Rev. **54:** 545–554, Oct. 15, 1938.
25. VON SCHUBERT, E.: Six and a Half Years' Experience in Carcinoma Therapy with Extra Hard Roentgen Rays. Radiology **31:** 142–148, August 1938.
26. WARD, C. B., WIRTH, J. E., AND ROSE, J. E.: One and One-Half Years' Experience with Supervoltage Roentgen Rays, with Special Reference to Carcinoma of the Urinary Bladder and Cervix Uteri. Am. J. Roentgenol. **36:** 368–378, September 1936.
27. WEBSTER, J. H. D. Wave-length as a Factor in Radiotherapy. Brit. J. Radiol. **11:** 108–111, February 1938.
28. WILLIAMS, I. G.: Very High Voltage X-Ray Therapy (Supervoltage). Brit. J. Radiol. **15:** 360–364, December 1942.

A New Principle in Roentgenography of the Lateral Lumbar Spine[1]

D. B. SLAUSON, R.T.
Milwaukee, Wis.

THE X-RAY examination of the lumbar spine has always been attended by considerable difficulty. Anatomically, the spine consists of twenty-four vertebral bodies separated by cartilaginous pads to permit flexibility. Roentgenographically, the demonstration of each vertebra and each intervertebral joint space is desired. This should be accomplished without distorting the shadow of the vertebral body over the joint space. As the patient lies on the side in position for a lateral roentgenogram, there is a curve in the spine due to the difference in width at the shoulder and hip areas, as compared to the waist. This is especially marked in women.

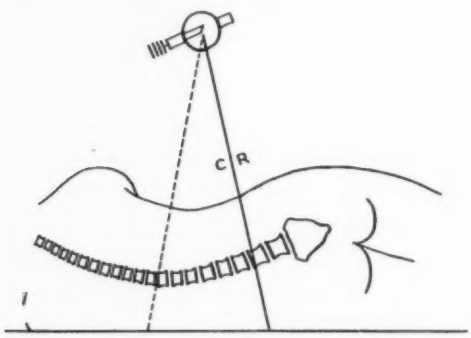

Fig. 1. Tube tilted to compensate for lumbar curve. *Result:* The intervertebral spaces in the lower thoracic and upper lumbar areas are obscured.

There are two methods generally advocated for correction of the curve of the spine when the patient is positioned for a lateral roentgenogram of the lumbar spine. One calls for tilting the tube until the central beam of radiation is at right angles to the plane of the region involved. In the other the spine is bolstered at the waist to eliminate the curve. Compensation is thus made for the curvature, but one important factor is neglected. That factor is the nature of the beam of radiation.

X-rays leave the anode of the tube in a divergent beam, only the central portion of which is perpendicular to the table top or the cassette. When the tube is tilted, as in the first method (Fig. 1), the central ray is directed through the level of the third lumbar vertebra. The intervertebral spaces in this region are demonstrated, but above this they are not well shown, being obscure in the upper lumbar and lower thoracic area. This is due to the upward curve of the spine in this region and the divergence of the x-ray beam.

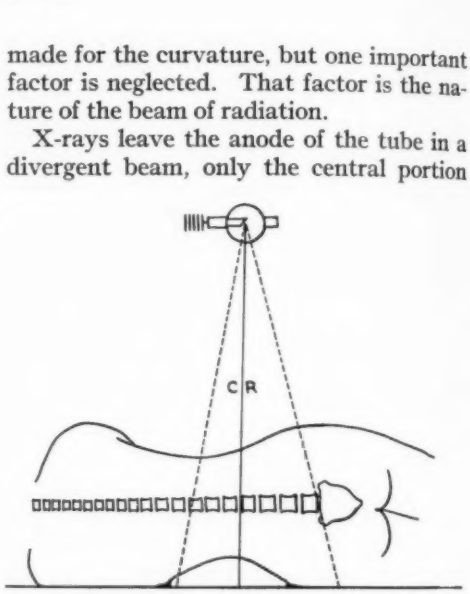

Fig. 2. Lumbar curve straightened by a non-opaque pad at the waist. *Result:* The intervertebral spaces at both ends of the roentgenogram are obscured.

In the second method (Fig. 2) the spine is bolstered up to a more horizontal plane with non-opaque pads. This method completely disregards the divergent nature of the radiation. As a result, the intervertebral spaces at either end are obscured, only those in the central portion of the roentgenogram being properly demonstrated.

[1] From the Department of Radiology, Columbia Hospital, Milwaukee, Wis., Dr. S. A. Morton, Director. Read before the Wisconsin Society of X-ray Technicians, Milwaukee, Sept. 25, 1943. Accepted for publication in June 1944.

Each method serves a purpose, but neither is satisfactory for the delineation of the entire lumbar spine on a single film.

The procedure to be described will consistently give accurate results and will show more vertebral bodies and interspaces without distortion than either of the methods mentioned above. The divergent beam of radiation is utilized to definite advantage instead of being regarded as something to be avoided. The distance factor is variable, being based on the radius of the curve of the spine, instead of being fixed at some convenient level.

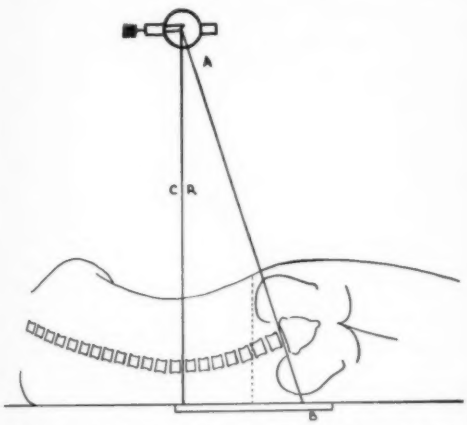

Fig. 3. Author's technic, in which the tube film distance is not fixed but is used as a variable factor. The procedure is as follows:

1. Determine the curve of the lumbar spine
2. Center the tube over the low point of the curve, usually at D11 or 12
3. Center the cassette at the iliac crest
4. Raise or lower tube to the point where line A-B intersects CR.
5. Correct exposure factors to compensate for increase or decrease of distance

Result: All intervertebral spaces are clear, even in patients with marked scoliosis.

The patient is placed in the usual position for lateral roentgenography of the lumbar spine. Because of its flexibility, and the fact that the shoulder and hip areas are wider than that of the waist, the spine lies in a long sweeping curve from the shoulders to the lumbosacral joint (Fig. 3). The tube is centered over the low point of this curve and directed perpendicularly to the table top. This point usually is at the level of the eleventh and twelfth thoracic vertebrae. The cassette is centered at the level of the iliac crest, and the tube is centered not to it but to the low point of the curve.

Fig. 4. Lateral view of lumbar spine made with author's technic.

The tube distance, as pointed out above, is a variable factor based upon the radius of the curve of the spine. If the curve is pronounced, the distance is shortened; when it is less marked, a greater distance is used. The divergent roentgen beam represents the radii of the curve, converging at a center point; this center point is the position of the tube. In practice this center is found by determining the low point of the curve. Then with a pointer or by inspection a line is projected through the lumbosacral joint (Line A–B, Fig. 3) and the tube is raised or lowered to the point where

it intersects the projected line. Before making the exposure, the proper adjustment for increased or decreased distance is calculated.

This technic provides a clear, unobscured image of all vertebral bodies and intervertebral spaces (Fig. 4). It can be employed with most of the equipment in use today. If, however, the equipment does not permit a distance greater than 36 inches, it may be difficult in many cases to obtain satisfactory results, since the average distance for optimum results is 38 to 40 inches.

SUMMARY

A method is described whereby satisfactory roentgenograms demonstrating clearly each intervertebral space can be obtained. The divergence of the roentgen beam is utilized and distance is varied.

Columbia Hospital.
Milwaukee 11, Wis.

NOTE: Subsequent to the initial presentation of this paper, an article by Caesare Gianturco appeared in the *American Journal of Roentgenology* (**50:** 695, November 1943), suggesting utilization of the divergent nature of the roentgen beam. This did not, however, stress the importance of variable distance and cassette center.

Further Studies on the Relation between Radiation Effects, Cell Viability, and Induced Resistance to Malignant Growth[1]

II. Effects of Roentgen Rays on Bagg-Jacksen Mouse Carcinoma 755 Irradiated in Vitro and in Situ

ANNA GOLDFEDER, D.Sc., M.U.C.

New York, N. Y.

IN A PREVIOUS study (1) attempts were made to correlate the effects of irradiation on living processes observed in experiments carried out *in vitro* with radiation effects *in vivo*. Mouse sarcoma 180 was used as an experimental subject in both procedures. While a dose of about 60,000 r in air was required to prevent the growth of tumor particles in a culture medium, a dose of 4,000 to 5,000 r in air applied to similar tumor particles prior to implantation was sufficient to prevent their proliferation in the animal organism. The implanted tumor fragments previously irradiated with dosages in the neighborhood of 5,000 r in air rendered the animals resistant to subsequent viable (non-irradiated) implants of the same type of tumor. In these animals no detectable tumor developed; that is, they became immune to tumor growth. On the other hand, animals implanted with fragments previously irradiated with dosages of about 60,000 r in air failed to show any such resistance. The massive dose (60,000 r in air), therefore, which prevented proliferation *in vitro*, was destructive not only for the proliferative power of sarcoma 180, but also for its immunizing factor. It was thus demonstrated that, in order to induce "immunity" to subsequent viable implants, the tumor fragments had to be attenuated, but not destroyed, by a relatively critical dosage of radiation. For sarcoma 180 this dosage was about 5,000 r in air.

It was deemed of interest to apply this method of investigation to other types of tumors, particularly to those of known genetic constitution grown in an inbred strain of animals. Such studies may have a twofold significance: (1) as furnishing a more precise measurement for the effectiveness of given dosages of radiation, the indicator being the ability of the irradiated implant to produce either a tumor or resistance to subsequent viable tumor implants; (2) as permitting generalizations on the possibility of inducing resistance to malignant growth by means of properly irradiated tumor implants. The present paper represents such an attempt, being one of a series of proposed studies.

METHOD AND MATERIAL

The tumor used in this experiment was the Bagg-Jacksen mouse carcinoma 755, grown in an inbred strain of mice, C57 "Y" black (2). This tumor originally arose in C57 black mice which had been subjected to forced breeding. The "Y" designates a substrain which exhibited a high mammary tumor incidence. The tumor is an alveolar mammary adenocarcinoma, consisting of small acini and, to a lesser extent, of sheets and strands of cells. It is firm in consistency, encapsulated, relatively slow growing, rarely becomes hemorrhagic, and never regresses spontaneously.

Since the radiosensitivity of this type of tumor has not been sufficiently studied, the first task was to determine the dose of radiation applied *in vitro* which would prevent an implant from producing a tumor in the animal organism and the dose required to make an actively growing tumor regress *in situ*, for it was observed, in some instances, that animals in which tu-

[1] This investigation was made possible by a grant from the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. From the Department of Hospitals and the Department of Surgery, 3d Surgical Division, New York University Medical College and Bellevue Hospital, New York. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

TABLE I: TUMORS PRODUCED BY IRRADIATED IMPLANTS
(200 kv., 20 ma., 0.5 mm. Cu + 1 mm. Al filter, H.V.L. 0.9 mm. Cu)

Experiment Number	Dose (r in air)	Latent Period (days)	"Takes" (per cent)	Average Initial Tumor Size (mm.)	Period of Tumor Growth (days)	Average Size of Tumors (mm.)
1	1,200	11–13	100.	5 × 5 × 4	58	35 × 28 × 19
2	1,500	14–16	100.	7 × 6 × 4	61	38 × 28 × 17
3	1,800	14–19	100.	4 × 4 × 3	59	27 × 19 × 12
4	2,000	16	100.	6 × 5 × 4	60	19 × 16 × 12
5	2,500	16–23	100.	5 × 4 × 3	58	16 × 16 × 10
6	3,000	18	85.5	6 × 4 × 4	58	16 × 12 × 9
7	3,500	18–20	58.6	4 × 3 × 3	60	12 × 9 × 6
8	4,000	20–24	25.0	4 × 3 × 2	57	9 × 8 × 4
9	4,300	26	6.6	3 × 2 × 2	62	8 × 5 × 4
10	4,500	0	0	0	0	0

Remarks: Each experiment included 5 or 6 mice. Therefore, the sizes recorded represent averages of 5 or 6 tumors. The tumors were measured in three dimensions.

Some of the experiments were repeated, and the results recorded are averages of single and repeated experiments.

In experiment 9, only one of 15 mice in 3 repeated experiments showed a tumor twenty-six days after implantation.

Three sets of experiments with doses of 4,500 r gave negative results, *i.e.*, no "takes" were observed.

mors regress either spontaneously or as a result of radiation treatment became resistant, also, to subsequent tumor implantation.

The same technic was used here as in previous experiments (1). The surface portion of a ten-to-twelve-day-old tumor was cut with sharp scissors into tiny fragments, varying from 1.2 to 2.0 mm. in diameter and weighing from 0.8 to 1.5 mg. Some of these fragments were used for implantation into control mice. Others were spread on a No. 1 round cover slip which had been attached to a mica sheet, covered with a Maximow slide, sealed with paraffin, and irradiated. In order to avoid evaporation of the tissue water, a strip of moist filter paper was placed in the concavity of the Maximow slide before sealing with paraffin. The radiation was applied by a pulsating potential oil-cooled Coolidge tube. The radiation factors were: 200 kv., 20 ma., 0.5 mm. Cu plus 1.0 mm. Al filtration, and 0.9 mm. Cu H.V.L. The tumor fragments were irradiated at 12.5 cm. distance from the target, and the average intensity was 577 r in air per minute. In figuring the dose received by the tumor fragments, the absorption of the radiation by the covering glass and mica sheet, which was about 10 per cent, was taken into consideration. The dose of radiation in each case was applied during a single exposure. Within fifteen to twenty minutes after irradiation, the tumor fragments were implanted into animals midway between the groin and the axilla by means of a trocar. Non-irradiated control tumor fragments were similarly implanted.

The majority of mice used in these experiments were males from five to six weeks old, weighing from 18 to 25 gm. They were kept in wooden boxes and fed with Purina dog chow and water *ad libitum*. Lettuce was added to the regular food once or twice weekly. As criteria of the radiation effects, the latent period, the number of "takes," and the size of the tumors produced by the irradiated implants were taken into consideration. The same indices were applied to tumors produced by non-irradiated implants.

For the study of the effects of x-rays on the tumor *in situ* a certain number (3 or 4) of tumor-bearing control mice were used from each series. During exposure these mice were fastened with adhesive tape to a sheet of lead 4 mm. thick, in which holes 2.5 cm. in diameter were made. The lead sheet was placed on a wooden stand. The mice were tightly fastened on the sheet in such a position that only the tumor was exposed through the hole. The radiation factors were the same as those used in the irradiation of the tumor fragments, except that the target-skin distance was 50 cm. The average intensity amounted to 43 r in air per minute. The tumors were ir-

TABLE II: TUMORS PRODUCED BY NON-IRRADIATED CONTROL IMPLANTS

Experiment Number	Latent Period (days)	Average Initial Tumor Size (mm.)	Period of Tumor Growth (days)	Average Size of Tumors (mm.)	Remarks
1	9	4 × 3 × 2	58	38 × 27 × 16	Each experiment included 5 or 6 mice. Therefore, the sizes recorded in this table represent averages of 5 or 6 tumors. The tumors were measured in three dimensions.
2	10	5 × 5 × 3	61	41 × 30 × 24	
3	10	5 × 5 × 3	59	35 × 28 × 18	
4	10	4 × 3 × 3	60	37 × 25 × 19	
5	7	3 × 2 × 2	58	36 × 31 × 26	
6	10	6 × 5 × 4	58	37 × 28 × 16	
7	9	5 × 4 × 3	60	39 × 28 × 21	
8	10	4 × 3 × 2	57	37 × 29 × 16	
9	10	5 × 4 × 4	62	42 × 38 × 20	
10	8	3 × 3 × 2	61	39 × 25 × 15	

radiated three times weekly, receiving one dose of 500 r in air at each exposure. Preliminary experiments with smaller doses of x-rays showed a continuous increase in the size of the initial tumor for a period of two weeks. The choice of 500 r in air was made because the mice seemed to endure repeated applications of this dose. Arrest of the tumor growth was obtained after several treatments. In some instances, where the mice did not appear in good health during the course of treatment, the irradiation was interrupted for a few days. (It should be pointed out that in this experiment attention was focused on producing regression of tumors for testing their capacity of inducing resistance in the host and not on the particular method of treatment.) The tumors, both irradiated and control, were measured in three dimensions twice weekly by means of calipers.

OBSERVATIONS ON IRRADIATED IMPLANTS OF CARCINOMA 755

In Table I are recorded typical results obtained after implantation of irradiated tumor fragments in mice. Each experiment comprised an average of five or six animals. Where tumors consisted of two separate lobes, the average size of both lobes was taken into consideration. Up to a dose of 1,200 r in air no marked difference in the rate of growth could be detected between the irradiated and control implants.

The effectiveness of irradiation on the tumor implants was primarily manifested in the latent period, *i.e.*, the lapse of time between the implantation of the tumor fragments and the occurrence of tumors of a measurable size. Among the animals which were implanted with non-irradiated tumor fragments, a latent period varying from seven to ten days occurred, while among the animals inoculated with irradiated tumor fragments the latent period extended from eleven to twenty-six days, varying with the dose. Some sets of experiments showed variation in the latent period for implants exposed to the same dose of x-rays. An analysis of the data for all experiments reveals that between 1,200 and 4,000 r in air the latent period varied from 11 to 20 days in some experiments and in others from 13 to 24 days. The prolonged latent period was not consistent, for in experiments 4 and 6 only one latent period occurred. Furthermore, in experiment 9, only one of 15 mice developed a tiny tumor twenty-six days after implantation, though the experiment was twice repeated. Consequently only one prolonged latent period was observed in this series of three experiments.

To explain the prolonged latent period there are two alternatives: first, that not all cells are equally affected by a given dose of radiation, which may be due to a difference in susceptibility of the cells during different stages of mitosis; second, that partially injured tumor cells may recover and produce a tumor after a comparatively longer period.

The size of the tumors produced by irradiated implants may be utilized as further evidence of effects produced by given doses of x-rays. Two-month-old tumors have been arbitrarily chosen for comparison. This relatively long period appeared

TABLE III: EFFECTS OF FILTERED X-RAYS ON THE GROWTH IN SITU OF CARCINOMA 755
(200 kv., 20 ma., 0.5 mm. Cu + 1 mm. Al filter, H.V.L. 0.9 mm. Cu)

Experiment Number	Size of Tumor Before Irradiation (mm.)	Total Dose (r in air)	Size of Tumor After Irradiation (mm.)	Remarks
1	22 × 13 × 11	4,500	8 × 8 × 5	The mouse died 22 days after the last treatment; the tumor was firm and fibrotic, not movable.
2	18 × 16 × 8	4,500	6 × 4 × 3	The mouse died 15 days after the last treatment.
3	17 × 12 × 8	4,500	9 × 6 × 4	The mouse died 12 days after treatment.
4	15 × 12 × 9	5,500	0	Tumor disappeared 7 weeks after treatment; gray hair appeared on the epilated sites.
5	17 × 13 × 11	5,500	6 × 4 × 3	The mouse died 6 weeks after treatment.
6	18 × 15 × 13	5,500	0	This mouse lived 6 weeks after the disappearance of the tumor. Gray hair appeared in the epilated sites.
7	18 × 8 × 6	5,500	7 × 6 × 4	Both mice died during the course of tumor regression.
8	17 × 10 × 6	5,500	3 × 2 × 2	
9	16 × 9 × 6	5,500	0	The mouse survived 5 weeks after the disappearance of the tumor. Gray hair appeared on the epilated sites during this period.
10	11 × 10 × 9	5,500	0	The mouse died 3 weeks after the disappearance of the tumor.

necessary for evaluation of the irradiation effects on implants, because of the moderate rate of growth of this tumor. As can be seen from Tables I and II, the tumors produced by irradiated implants within a period of about two months are smaller than the tumors produced by unirradiated implants. This difference is more striking in the experiments with larger doses of radiation. Thus, in experiments, 1, 2, and 3 (Table I) the difference in average size between the tumors produced by an irradiated implant and those in the controls, is not so great as in the later experiments. A drastic decrease in the average tumor size occurred in experiments 7, 8, and 9, *i.e.*, within the threshold doses of 3,500 and 4,300 r in air. These observations parallel those of the prolonged latent period.

In summarizing the results recorded in Table I, it may be concluded that the lethal dose for implants of carcinoma 755, under the experimental conditions here applied, lies between 4,300 and 4,500 r in air. Furthermore, the tumors produced by the implants irradiated with 2,000 to 4,300 r grew more slowly and were smaller than those produced by non-irradiated implants in the same length of time.

OBSERVATIONS ON TUMORS (CARCINOMA 755) IRRADIATED IN SITU

Of 39 tumor-bearing animals treated with x-rays, only 10, recorded in Table III, will be discussed here. As previously mentioned, the response of Bagg-Jacksen adenocarcinoma 755 to x-rays has not hitherto been investigated to any great extent.[2] Some details obtained from this study seem, therefore, of special interest.

While in our previous experiments (1) mouse sarcoma 180 regressed rapidly after a dose of 2,000 to 3,000 r in air, the mammary adenocarcinoma (carcinoma 755) used in the present experiment increased in size after a similar dose. Moreover, a characteristic of carcinoma 755 is its slow regression after the course of treatments. It was weeks or months before the tumor decreased to one third of its original size or before it disappeared completely after a total dose of 5,500 r in air. It became firm and attached to the skin during the course of regression, thus indicating that fibrosis occurred within the mass and its surrounding area. In some instances the fibrotic tumor remained stationary for some time, *i.e.*, no change in size could be detected by measurement with calipers. After such a

[2] The only reference available is a publication by Plaut et al. (3), who studied the influence of diet and foster nursing on the response of the Bagg-Jacksen tumor to x-rays. The authors applied a single dose of 2,500 r in air to the tumor, which was on the lateral aspect of the right thigh. They admit, however, that the experiment was complicated by the implantation of another type of tumor (Yale carcinoma) into the same animal and also by the variations in the diet. Consequently they did not draw any definite conclusions from their study.

period, the tumor either renewed its growth or was gradually absorbed. Seldom did ulceration occur in actively growing tumors or in tumors which regressed.

The six mice recorded in Table III, experiments 1, 2, 3, 5, 7, and 8, exemplify the slow regression of the tumors and the death of animals when the tumor had decreased to about one third of the original size. No metastases were discovered at autopsies of animals in which tumors regressed either partially or completely.

Of the four mice successfully treated (experiments 4, 6, 9, and 10), No. 4 may serve as a typical case. This animal received a total dose of 5,500 r in air. Epilation of the left and right sides of the lateral thoracic regions occurred during and after the radiation treatments. The tumor decreased in size after receiving about 4,000 r in air. It regressed slowly following the total dose of 5,500 r and disappeared seven weeks after the last treatment. This mouse survived three months after the disappearance of the tumor. During this period gray hairs instead of the natural black ones appeared on the epilated lateral thoracic regions (left and right sides). Though irradiation was confined to an area only 2.5 cm. in diameter on the left side, where the tumor was located, the entire right side of the mouse, including the leg, was covered with gray hair (Fig. 1). The occurrence of gray hair on the right side of the mouse may indicate an exit effect of the rays. Similar observations were made on mice 6, 9, and 10, which also survived several weeks after disappearance of the tumor. The restoration of growth of hair on the epilated areas demonstrates the partial recovery of hair follicles after doses as high as 5,000 to 5,500 r in air. These doses, on the other hand, were destructive to the pigment, since the new growth of hair was gray instead of the original black. These observations substantiate those of Hance and Murphy (4), who described the growth of white hair on colored mice in areas temporarily epilated after irradiation. No ulceration of the skin of the irradiated areas was noticed, an observation indicative of the high resistance of mouse skin to roentgen radiation.

Fig. 1. Growth of gray hair on epilated areas following irradiation.

Twenty-nine of the 39 tumor-bearing mice treated with x-rays died during or shortly after the course of treatment. The high mortality among the mice treated with x-rays in comparison to the control tumor-bearing mice, which survived six to eight weeks longer, may have been due to the effects of the x-rays on the internal organs. The importance of a better method of treatment to secure more protection of the animal organism is evident. It is obvious that the usual high mortality following direct irradiation of the tumors *in situ* precludes this procedure as a practical method of inducing "immunity." The next logical step is to experiment along the lines which have been followed with sarcoma 180, using properly attenuated implants irradiated *in vitro*, thus sparing the host the harmful effects of x-rays on the internal organs and increasing his chance of survival. This holds true particularly in experiments on small animals. The use of larger animals for this type of experiments may, however, be more satisfactory.

The small number of cured animals in the present study limited experiments to determine their response to further viable tumor implants. One attempt was made. Mouse 4, which survived for the longest period, was reinjected with a fresh viable implant of carcinoma 755 two months after regression of the first tumor. The implant produced a tumor 3 × 3 × 2

mm. sixteen days following implantation. This tumor slowly increased in size and measured $8 \times 5 \times 4$ mm. at the death of the mouse, eighteen days later. Sections of the tumor, which was removed shortly after the death of the animal, contained viable tumor cells.[3] The question, whether or not this tumor would have continued to grow or would eventually have regressed cannot be answered. The latent period of sixteen days and the relatively slow rate of growth suggest some resistance on the part of the host. It may also be assumed that this resistance would have been greater, had the lapse of time between the regression of the first tumor and reimplantation been shorter. No definite conclusion can be drawn, however, from a single case.

[3] I am indebted to Dr. F. E. Stewart of Memorial Hospital, New York, for the interpretation of the histologic slide.

SUMMARY AND DISCUSSION

The purpose of this study was twofold: first, to determine what dose of x-radiation applied to tumor fragments *in vitro* would inhibit their growth upon transplantation into mice, and second, to determine the dose of radiation which would make an actively growing tumor regress *in situ*.

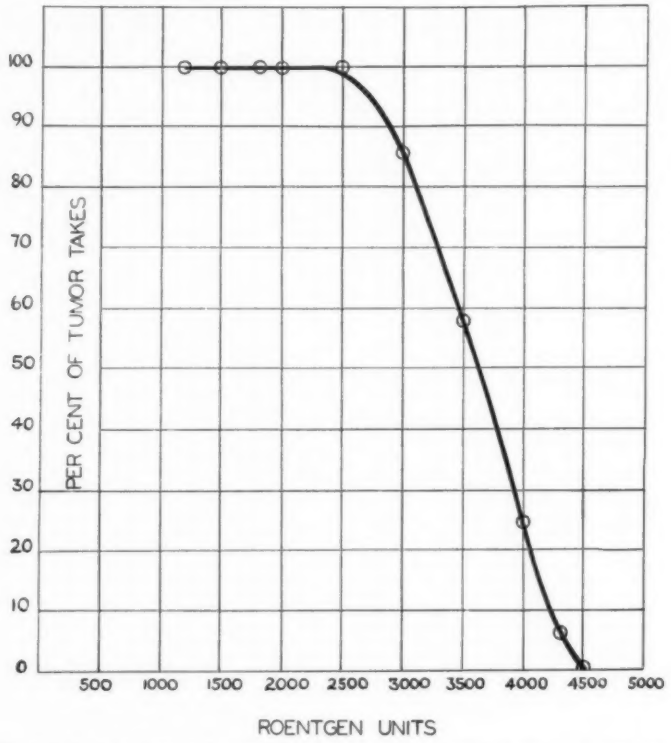

Fig. 2. Survival curve for mammary adenocarcinoma 755 exposed to roentgen rays.

It was found, that a dose of 3,500 r in air (H.V.L. 0.9 mm. Cu) applied to tumor particles of the Bagg-Jacksen mammary mouse carcinoma 755, *in vitro*, permitted 58.6 per cent "takes," while a dose of 4,500 r in air entirely prevented the growth of the irradiated implants. A comparison of the results obtained in this study with those obtained by other investigators seeking to determine lethal doses for various tumors irradiated either prior to implantation or *in situ*, is presented in Tables IV

TABLE IV: DOSE OF ROENTGEN RAYS INHIBITING GROWTH OF TUMOR FRAGMENTS IN SITU, AS DETERMINED BY DIFFERENT INVESTIGATORS

Investigator	Type of Tumor	Physical Factors	Dose of Radiation	Remarks
Westergaard (5)	Jensen mouse carcinoma	Bauer tube 0.5 ma. 14 cm. distance No filter	1¼ S.E.D.	
Contamin (6)	Mouse adenocarcinoma B	0.8 ma. 12 cm. distance 0.2 mm. Al	About 3 hr.	No physical factors given
Wedd and Russ (7)	Mouse carcinoma 63	Sparkgap 6–10 cm. 4 amp.	About 5 S.E.D.	No exact physical factors given
Wood and Prime (8)	Sarcoma 180 Sarcoma 10 Flexner-Jobling rat carcinoma and mouse carcinoma 11	25 kv.; 5 ma. 23 cm. f.d. 3 mm. Al	About 5 S.E.D. About 4 S.E.D.	
Kok and Vorlaender (9)	Ehrlich mouse carcinoma	80 kv.; 8 ma. 20 cm. f.d. 0.5 mm. Cu	1,500 e About 9 S.E.D.	
Krebs (10)	Mouse carcinoma Mouse sarcoma	142 kv.; 2.8 ma. 23 cm. f.d. 5 mm. Al	About 6 S.E.D.	The sarcoma was produced by tar. The carcinoma arose among the mice used by the author
Packard (11)	Sarcoma 180	550 kv.; 3.2 ma. 50 cm. distance 1 mm. steel filter	2,700 r in air	
Sugiura (12)	Sarcoma 180	200 kv.; 15 ma. 50 cm. distance 0.2 mm. Sn, 0.25 mm. Cu, 2.0 mm. Al	2,800–3,000 r in air	
Lawrence et al. (13)	Mouse carcinoma	200 kv. 36 cm. f.d. 0.45 mm. Cu and 1 mm. Al	4,400 r in air	The tumor particles weighed about 8 mg.
Lawrence et al. (14)	Mouse sarcoma 180	200 kv. 36 cm. f.d. 0.45 mm. Cu and 1 mm. Al	2,800–3,000 r in air	
Toniolo (15)	Galliera sarcoma	165 kv.; 3 ma. 25 cm. distance 3 mm. Al and 0.5 mm. Cu	3,500 r in air	The same dose destroyed the tumor *in situ*
Sahler and Warren (16)	Brown-Pearce rabbit carcinoma	200 kv.; 25 ma. 0.5 mm. Cu and 1 mm. Al	6,000 r in air	
Eisen (17)	Transplants of a spontaneous mammary adenocarcinoma (R2426)	200 kv. 37 cm. f.d. 0.5 mm. Cu	5,000 r in air	
Henshaw (18)	Mouse sarcoma 37	200 kv.; 20 ma. 25 cm. f.d. 0.25 mm. Cu and 0.55 mm. Al	5,000 r in air	
Goldfeder	Mouse adenocarcinoma 755	200 kv.; 20 ma. 0.5 mm. Cu and 1 mm. Al	4,300–4,500 r in air	

TABLE V: DOSE OF ROENTGEN RAYS CAUSING REGRESSION OF TUMORS IN SITU, AS DETERMINED BY DIFFERENT INVESTIGATORS

Investigator	Type of Tumor	Physical Factors	Dose of Radiation	Remarks
Contamin (6)	Mouse adenocarcinoma B	0.8 ma. 12 cm. distance 0.2 mm. Al	About 3 hr.	No physical factors given. Single exposure
Wedd and Russ (7)	Jensen rat sarcoma	Sparkgap 6–10 cm. 4 amp.	About 4 S.E.D.	Single exposure
Wood and Prime (8)	Sarcoma 180 Sarcoma 10	25 kv.; 5 ma. 23 cm. f.d. 3 mm. Al	About 5 S.E.D.	Single exposure
Kok and Vorlaender (9)	Ehrlich mouse carcinoma	80 kv.; 8 ma. 20 cm. f.d. 0.5 mm. Cu	250 e	Single exposure
Krebs (10)	Mouse carcinoma Mouse sarcoma	142 kv.; 2.8 ma. 23 cm. f.d. 0.5 mm. Al	About 6 S.E.D.	Same dose for both tumors in vitro and in situ
Samssonow (19)	Spontaneous mouse tumors	180 kv.; 5 ma. 30 cm. f.d. 8 mm. Al	6,060 r–1,380 r	Doses applied in three sittings, 24–48 hr. intervals
Sugiura (12)	Sarcoma 180	200 kv.; 30 ma. 50 cm. f.d. 0.5 mm. Cu and 1.6 mm. Al	1,800 r in air	Single exposure
Snellman (20)	Jensen rat sarcoma		4,000–5,000 r in air	Single exposure
Toniolo (15)	Galliera sarcoma	165 kv.; 3 ma. 23 cm. f.d. 3 mm. Al and 0.5 mm. Cu	3,500 r in air	Single exposure
Oughterson et al. (21)	Yale mouse carcinoma	90 kv.; 4 ma. 23.5 cm. f.d. No filter	5,000 r in air	Single exposure
Reinhard and Warner (22)	dbr. B	200 kv. 30 cm. f.d. 5 mm. Cu	1,500 r in air	Single exposure
Goldfeder	Mouse adenocarcinoma 755	200 kv.; 20 ma. 0.5 mm. Cu and 1 mm. Al	5,500 r in air	Eleven exposures

and V. As can be seen from these tables, there is an apparent quantitative disagreement as to lethal dosages among various investigators. This holds true particularly in the earlier investigations, before the standard r was adopted. The different technical procedures applied are also a factor influencing the final results. In view of the lack of a basis for comparison, no general conclusions can be drawn regarding the relative merits of the various results obtained. The only close agreement is between the results recorded in this paper and those obtained by the Yale group, which includes Oughterson (21) and Lawrence (13) and their associates. Lawrence and his associates found that a dose of 4,000 r in air was required to prevent an implant from producing a tumor, while Oughterson, using the same inbred strain of animals ("A" albino) and a similar type of tumor of known genetic constitution, found that a dose of 5,000 r in air caused regression *in situ*. As recorded in the present paper (Tables I and II), the dose required to prevent implants of carcinoma 755 from producing a tumor in an inbred strain of mice (C57 "Y") which has a high

incidence of spontaneous mammary carcinoma, lies between 4,300 and 4,500 r in air; tumors of the same type irradiated *in situ* regressed following a total dose of 5,500 r in air applied fractionally. Inasmuch as the experimental procedures of the Yale investigators differ only slightly from those in the present study, and since the final observations are similar, it would seem reasonable to postulate that similar types of tumors, of known genetic constitution, grown in an inbred strain of mice, require similar doses of radiation in treatment.

Another point of interest is the fact that the dose of x-rays necessary to prevent an implant from producing a tumor does not differ widely from that required to destroy a tumor *in situ* when an inbred strain of mice is used. In connection with these observations it may be noted that Sugiura (12) found the dose of radiation required to destroy mouse sarcoma 180 *in vivo* to be about one half that required to inhibit the growth of implants of the same type of tumor. Sugiura, however, used hybrid mice in his experiments. Oughterson *et al.*, using a transplantable mammary carcinoma, showed "1.0 per cent cure with 2,500 r in air and 48 per cent cure with 5,000 r in air. Similar irradiation of the same tumor in hybrid mice showed 82 per cent and 97 per cent cures, respectively." The observations made by Oughterson and his associates and those presented in this paper suggest that quantitatively similar results are obtained from experiments carried out *in vivo* and *in vitro* in which a tumor of known genetic constitution and an inbred strain of mice are used. If it is true that tumors grown in hybrids require smaller dosages than those grown in inbred strains, this represents an advantage for the therapy of cancer in man, inasmuch as here we are dealing exclusively with hybrids.

As to the problem of inducing "immunity" to mammary mouse carcinoma 755, more extensive experimentation is required than could be accomplished with the available supply of the particular strain of mice at this time.[4] The lethal dose for the tumor implants having been determined, the next step will be to find the threshold dose for the attenuation of the implants to a point at which they will produce no tumor but will induce resistance to subsequent viable implants. This method may also permit the classification of those tumors which do and which do not produce resistance to malignant growth in animals and possibly throw some light on the relation between the genetic constitution of the host and the immunizing capacity of the tumor implants.

NOTE: The author wishes to express her appreciation to the Department of Radiation Therapy, Bellevue Hospital, and to Mr. Carl B. Braestrup of the Physics Laboratory, for their kind and valuable cooperation.

444 East 52d St.
New York, N. Y.

BIBLIOGRAPHY

1. GOLDFEDER, A.: Relation between Radiation Effects and Cell Viability as Indicated by Induced Resistance to Transplanted Tumors. Radiology **39:** 426–431, October 1942.

2. BAGG, H. J., AND JACKSEN, J.: Value of a Functional Test in Selecting Material for a Genetic Study of Mammary Tumors in Mice and Rats. Am. J. Cancer **30:** 539–548, July 1937.

3. PLAUT, J. A., TENNANT, R., AND OUGHTERSON, A. W.: Irradiation of Transplanted Bagg-Jacksen and Yale Carcinomas in Mice as Affected by Diet and Foster Nursing. Cancer Research **2:** 546–550, August 1942.

4. HANCE, R. T., AND MURPHY, J. B.: Studies on X-Ray Effects: Prevention of Pigment Formation in Hair Follicles of Colored Mice with High Voltage X-Ray. J. Exper. Med. **44:** 339–342, September 1926.

5. WESTERGAARD, M.: Rontgenstraalernes Virkning paa maligne Svulster. Thesis, Copenhagen, 1909.

6. CONTAMIN, M.: Rayons X et cancer expérimental de la souris. Bull. Assoc. p. l'étude du cancer **3:** 160, 1910.

7. WEDD, B. H., AND RUSS, S.: Effect of Roentgen and Radium Radiations upon the Viability of the Cells of Mouse Carcinoma. J. Path. & Bact. **17:** 1, 1912.

8. WOOD, F. C., AND PRIME, F.: Lethal Dose of X-Rays for Cancer Cells. J. A. M. A. **74:** 308, 1920.

WOOD, F. C.: Effect on Tumors of Radiation of Different Wave Lengths. Am. J. Roentgenol. **12:** 474–482, November 1924.

WOOD, F. C.: Further Studies in the Effectiveness of Different Wave Lengths of Radiation. Radiology **5:** 199–205, September 1925.

9. KOK, F. R., AND VORLAENDER: Biologische Versuchungen ueber die Wirkung der Bestrahlung auf das Karzinom. Strahlentherapie **14:** 31, 1923; **17:** 327, 1924; **18:** 90, 1924.

[4] The author wishes to express her gratitude to Dr. H. J. Bagg of Memorial Hospital, New York City, for making available a portion of the animals used in his own work for these experiments.

10. KREBS, C.: Effect of Roentgen Irradiation on the Interrelation between Malignant Tumors and Their Hosts. Acta radiol., supp. 8, 1929.

11. PACKARD, C.: Biological Effectiveness of High-Voltage and Low-Voltage X-Rays. Am. J. Cancer **16:** 1257–1274, November 1932.

12. SUGIURA, K.: Studies on Radiosensitivity of Mouse Sarcoma 180 Irradiated *in vivo* and *in vitro*. Radiology **29:** 352–361, September 1937.

SUGIURA, K.: Effect of Roentgen Rays on the Growth of Mouse Sarcoma 180 Irradiated *in vivo*. Radiology **28:** 162–171, February 1937.

13. LAWRENCE, J. H., HORN, R., AND STRONG, L. C.: Radiation Studies on a Mammary Carcinoma of Mice. Yale J. Biol. & Med. **10:** 145–154, December 1937.

14. LAWRENCE, J. H., AEBERSOLD, P. C., AND LAWRENCE, E. O.: Comparative Effects of X-Rays and Neutrons on Normal and Tumor Tissue. Proc. Nat. Acad. Sci. **22:** 543–557, September 1936.

15. TONIOLO, G.: Wirkung der Röntgenstrahlen auf das Galliera-Sarkom *in vivo* und *in vitro*. Strahlentherapie **65:** 375–396, 1939.

16. SAHLER, O. DEP., AND WARREN, S. L.: Physiological Effects of Radiation: The *in vitro* Single Massive Roentgen-Ray Dose (at 200 kv.) for the Brown-Pearce Rabbit Epithelioma. Am. J. Roentgenol. **41:** 954–961, June 1939.

17. EISEN, M. J.: Transplantable Carcinoma of the Rat Breast. Am. J. Cancer **39:** 36–44, May 1940.

18. HENSHAW, P. S.: Influence of Irradiation-Killed Cells on Tumor Growth. J. Nat. Cancer Inst. **4:** 305–307, December 1943.

19. SAMSSONOW, N.: Untersuchungen über die Röntgenbestrahlung der spontanen Adenocarcinome der Milchdrüse bei der Maus. Ztschr. f. Krebsforsch. **36:** 442–458, 1932.

20. SNELLMAN, B.: Attempt to Develop Reduced Radiosensitivity in Jensen Rat Sarcoma by Means of Roentgen Irradiation. Acta radiol. **16:** 545–556, 1935.

21. OUGHTERSON, A. W., TENNANT, R., AND LAWRENCE, E. A.: Tumor Response and Stroma Reaction Following X-Ray of a Transplantable Tumor in Inbred Strains of Mice. Yale J. Biol. & Med. **12:** 419–425, March 1940.

22. REINHARD, M. C., AND WARNER, S. G.: Preliminary Report of the Effect of X-Rays on a Tumor of Known Genetic Constitution. Radiology **34:** 438–439, April 1940.

EDITORIAL

Presidential Address[1]

The By-laws of the Radiological Society of North America stipulate that the President of the Society deliver an address at the Annual Meeting. In my effort to abide by this provision, I shall not attempt to enter into any scientific discussion, as others better qualified have contributed to the scientific program presented in the various sessions of the Assembly.

Wartime conditions and patriotic motives resulted in the cancellation of the meetings of the American Roentgen Ray Society and the Radiological Society of North America in 1943. The wisdom of that course is not now questioned, though at the time there were many who expressed disappointment and regret. Early in this year, it became evident to the officers and committees of both societies that cancellation or postponement of our Annual Meetings in 1944 would be most unfortunate and might result in justifiable protest from the members. Realizing these sentiments, each society had originally planned to conduct its Annual Meeting, as in the past. By a most fortunate circumstance, officers and some members of committees of the two groups were in Chicago in February of this year, attending the Annual Meeting of the American College of Radiology. At the instigation of several of the officers, an informal discussion resulted in the suggestion that the two societies meet in joint session. There were many advantages evident if such an arrangement could be accomplished. The announcement of a proposed Joint Meeting was enthusiastically received and gave immediate assurance of the desirability and popularity of such a departure from the established custom.

The session in which we are now engaged may quite correctly be designated as a "Wartime Congress of American Radiologists." Invitations have been extended to our colleagues in Cuba, Mexico, Central and South America, and we are happy to welcome some of our fellow radiologists from these neighboring countries. Many who are unable to attend have extended greetings and expressed regrets because of their enforced absence. We are particularly honored and delighted to have with us so many members and guests wearing the Service uniforms of the United States and Canada. The importance of roentgenology in our military activities is evident by the many papers and exhibits dealing primarily with our specialty as applied to the various branches of military medicine.

The world-wide struggle in which we find our country engaged has caused many of our members to enlist in the Medical Services of the Army and Navy. I need not remind you of their splendid record of accomplishment. They have contributed their talent and energy, patriotically and unselfishly, to the successful prosecution of our war effort, which at the moment appears to be nearing completion in the European theater.

Many of our members who desired to enter the military service were disqualified for physical reasons; others were needed to

[1] Delivered before the Radiological Society of North America at its Annual Meeting, in conjunction with the American Roentgen Ray Society, Chicago, Ill., Sept. 27, 1944.

carry on teaching activities and care for civilian practice. When it became necessary to develop a large Army to meet our military requirements, it also became necessary to develop a medical personnel of proportionate size. Early in these developments, it became evident that the need for military roentgenologists could not be met by the number of trained men available. It seemed desirable, therefore, to give intensive training to a group of qualified physicians who, although they had no previous experience in radiology, were selected by the Army officers to enroll in a special short-term training program. The manner in which this perplexing problem was solved has been ably discussed by Col. B. R. Kirklin, in his address before the opening assembly of the meeting. The splendid results accomplished by the intensive training given to this selected group with little, if any, previous experience in roentgenology merit our sincere appreciation and commendation.

Col. A. A. deLorimier, Commandant of the Army School of Roentgenology, has been in charge of the organization and execution of the emergency training program. The subjects covered have been carefully selected, and the curriculum, as outlined by Colonel deLorimier, would indicate that those who successfully completed the course obtained a very excellent fundamental knowledge of roentgenology.

Approximately 825 have completed the course and are now serving in various Army stations, hospitals and outposts, wherever possible under the supervision of well trained and qualified roentgenologists. At the completion of the course, a questionnaire is submitted to each officer. Most of the questions have to do with suggestions for improvement of the course, but each man is also asked to comment on post-war plans. About one-third of the group have indicated their intention of continuing in radiology. The remainder expressed a preference to return to practice in other fields of medicine. Many of the latter group, entirely unsolicited, expressed the opinion that the course had provided an insight into the science of radiology that was most advantageous and indicated, furthermore, that through their training they had acquired a more sympathetic understanding of the manner of referring cases and how to co-operate more intelligently with the roentgenologist.

Colonel deLorimier makes this interesting personal observation: "I do have the opinion that the scientific viewpoint, emphasizing diagnostic criteria rather than picture impressions, is not ordinarily impressed upon the medical student. Too many of the doctors who have come to this school seem to think that the roentgenologist merely looks at a film and gives an overall impression of the case."

One of the chief topics of discussion today has to do with post-war planning. In an effort to acquire some insight into these discussions as they occur in groups of Medical Service men, a number of officers were consulted directly and indirectly. Their comments regarding present and future conditions in medical fields should be of interest and importance to us.

It is immediately apparent that all of those who have been questioned, whether in the United States or in foreign service, are agreed on one point—namely, that they are unequivocally opposed to any form of Federal-controlled medicine, and they are, furthermore, particularly concerned by the inroads being made and attempted by those agencies whose avowed or implied purpose it is to socialize medicine. These men are in most instances well aware of the measures that have been taken by those physicians who are guarding the home front to prevent such an occurrence, but they are frankly concerned about the apparent apathy of some of their colleagues. One group of officers stated that, in their opinion, organized medicine, particularly the parent organization, as well as some state and county societies, has not been entirely representative or democratic.

There also exists the impression that conditions within some branches of organized medicine are comparable in many ways to conditions prevalent in certain

non-medical groups, where the wishes of the rank and file are disregarded. A plea is made for a more equitable form of medical policy-making and the elimination of certain bureaucratic tendencies within medical ranks.

Quite obviously, such discussions are evidences of what medical men in our Armed Forces are thinking about, and give every indication that we, as physicians, no matter what our specialty, must devote serious thought to some problems that will certainly confront us in the very near future.

American resourcefulness, ingenuity, determination, and ability, coupled with superior scientific attainments, have been the predominating factors in the prosecution of our war efforts, which give every indication of the early subjugation of our adversaries. We share with others a justifiable pride in the part which radiology has taken in these accomplishments. These men of medicine, our colleagues, who have made such valuable contributions, surely deserve every consideration in the readjustment which will inevitably ensue after peace is assured. Obviously, such readjustment is of prime importance to all of us, whether we have participated in military or civilian activities during the war.

For purposes of this discussion, radiologists in all the branches of the Service may be placed in three groups: (1) those who were recognized and established radiologists before entering military service; (2) those with partial training, such as interns and residents in qualified hospitals, as well as those who had partial training in private practice; (3) those who had no previous training in radiology but who, through available military facilities, have been given intensive specialized training and have had varying degrees of actual experience and wish to continue in this field.

In the first group are many of our leading radiologists who, in most instances, were well established in hospital or private practice at the time they entered military service. Undoubtedly, a number of these vacated positions in industry or on hospital staffs. Every consideration should be given to the restoration of the pre-war status of this group, with the utmost regard for their military attainments. Demotions or replacements on hospital staffs without justifiable reason should be vigorously opposed.

The second group, namely those who were partially trained in radiology—our seniors and residents—have undoubtedly acquired considerable experience in military radiology and should be given due recognition if they elect to resume their pre-war status. Many of this group will now be qualified to enter private practice, and these should be given guidance and assistance in obtaining suitable locations or associations. We believe it should be the function of established radiologists to assume this obligation. We agree with Colonel Kirklin's opinion that due consideration should be given these men for the time they have spent in military service, as it applies to a continuation of hospital training and the requirements of the American Board of Radiology.

The third group, or those who have attended the intensive course of instruction and have subsequently been assigned to duty in some phase of military roentgenology, cannot be disregarded in our post-war planning. Their rather rapidly acquired knowledge of radiology has stimulated their interest in our specialty, and a considerable number (about one-third) will elect to remain in its practice. This group has had no experience in the civilian phases of roentgenology and, obviously, will require further training if they are to qualify for certification by the American Board of Radiology.

There is every indication that the number of available trainees, as well as qualified radiologists, will not be adequate to meet our civilian needs for some time after the war. We are informed that, because of draft requirements, the number of premedical students is insufficient to provide the usual quota of medical students for some time. That this situation is known to our medical educators is demonstrated

by the support given the Miller Bill, HR No. 5128, which would provide for deferment of approximately 6,000 pre-medical students annually. It is obvious that we must probably look to other sources for our supply of interns and residents. May we suggest that, when possible, we create opportunities for those of the third group, mentioned above, who are qualified and desire to continue their training, by accepting them as seniors and residents. Such an arrangement might be mutually advantageous.

Economics and hospital relationships are subjects which still attract our attention and will certainly be accentuated in the post-war period. You are well aware that, even though radiologists are physicians—licensed and authorized to practise medicine—radiology has not always been recognized as the practice of medicine. An attempt has been made by certain proponents of the Blue Cross Insurance plan to differentiate between technical and professional services. The pernicious and far-reaching influence of such a division would be most disastrous. Efforts of influential radiologists and others who are cognizant of the dangers of such an arrangement have thus far succeeded in preventing this proposed division, but rest assured that, if we relax our vigilance, some unscrupulous insurance salesman will surely be ready to amplify his insurance scheme by selling to policyholders a ticket for x-ray pictures under the guise of competent ethical roentgenological examinations. In this regard, our objective is not one of economics but rather the principles of practice whereby, in all plans for distribution of health service, the radiologists be treated as self-employed physicians.

The proper teaching of physics, particularly as applied to therapeutic radiology, has apparently not received adequate attention in the past. Our physicists are constantly stressing the necessity of more concentrated efforts along this line. This is particularly important in view of the very rapid progress being made in the development of mechanical devices and radioactive therapeutic agents. We believe that provision should be made whereby necessary facilities will become available for the teaching of physics in institutions otherwise qualified to train resident radiologists. This need not require a full-time physicist, but certainly there should be an arrangement whereby the services of a physicist on a part-time basis could be obtained for this purpose.

Another item to which our attention has been directed has to do with the Army- and Navy-trained x-ray technicians. It is estimated that several thousand enlisted men have been trained for this particular purpose, and a portion of these have acquired a great deal of actual experience. It is obvious, of course, that not all of them will wish to continue this activity, but certainly more men will be available than can possibly be utilized in civilian practice. Undoubtedly, industry will absorb some of these, but it is not apparent at this time what disposition can be made by radiologists of those who, prior to the war, had no radiological training but may desire to continue their war-time training and activities.

You are, undoubtedly, all aware that recently a bill has been introduced in the Congress of the United States whereby x-ray technicians would become eligible for commissions in the Army. The merits of such a measure should be most carefully evaluated before receiving the support of our national radiological organizations.

We have touched briefly on some of the matters that will require our careful attention in any post-war planning which we may consider or undertake.

Quite a number of medical societies—local, state, and national—believe they have a very definite responsibility in this regard, and have appointed committees to study these problems and make recommendations. It would seem desirable that we, as radiologists, recognize our responsibility as it pertains to our specialty. May we, therefore, suggest to the incoming officers that this function be undertaken at the earliest possible time and, if necessary, a

special coordinating committee, representing all the societies, be appointed to act in the best interests of all concerned.

We, as radiologists, enjoy the rich heritage of nearly a half-century of unparalleled progress and scientific accomplishment. The incomparable vigor of this, the youngest specialty in medicine, is a lasting tribute to those pioneers who, although only vaguely visualizing the possibilities of radiology, builded well the foundation thereof.

The rapid progress which has been made in the development and application of radiology in the diagnosis and treatment of disease during the past two decades is, indeed, an enviable record. The introduction of such procedures as bronchography, encephalography, myelography, intravenous urography—to mention but a few of the more recent discoveries—has opened new vistas for our diagnostic and therapeutic armamentarium which have almost limitless possibility.

Science is the predominating factor in the winning of this war, and science will also play a most important role in the era of peace. As a result of military experience, we may expect many new and startling developments in the field of diagnostic and therapeutic radiology.

In closing, may I urge that all members give their support to the officers whose duty it shall become to guide our destiny through the interesting years which lie before us. If we all accept the responsibility which is ours, our progress cannot be impeded.

E. R. WITWER, M.D.

Leo G. Rigler, M.D.—An Appreciation

Over one hundred friends of Leo G. Rigler gathered at a special dinner in Minneapolis, Dec. 9, 1944, to wish him well. The occasion was the fall meeting of the Minnesota Radiological Society, and the guest speaker was Fred J. Hodges, Professor of Roentgenology, University of Michigan, Ann Arbor. Walter J. Ude, representing the Minnesota Radiological Society and friends of the honored guest, gave a sum of $10,000 to the University of Minnesota to establish the Leo G. Rigler Lectureship in Radiology. This was accepted by Dean H. S. Diehl. Speakers were Robert G. Allison, George E. Fahr, E. T. Bell, and others. For some time the radiologists have wanted to express to Doctor Rigler their appreciation of his untiring efforts in their behalf. When his friends in other branches of medicine heard of this proposal, they too wanted to help, and the sum accumulated so rapidly that it quickly reached the desired amount.

Leo George Rigler was born Oct. 6, 1896, in Minneapolis. He attended the University of Minnesota, from which he received his M.D. in 1920. Following an internship in St. Louis City Hospital, St. Louis, Missouri, and practice in North Dakota, he was named teaching fellow in Internal Medicine, University of Minnesota (1921–22). The following year he was appointed Roentgenologist at Minneapolis General Hospital. He was named Associate Professor of Radiology in the University of Minnesota in 1927, and Professor in 1929. In 1935 he became chief of the department and has served in that capacity to date. In 1930 the State Board of Institutions made him a consultant. In 1941 the Minneapolis General Hospital named him chief of the Department of Roentgenology. Prior to accepting the departmental appointment, Doctor Rigler completed his studies in Europe, spending most of his time with Professor Forssell in Sweden. Here he also learned to speak Swedish.

Doctor Rigler is a member of Alpha Omega Alpha, Sigma Xi, American Medical Association, Hennepin County Medical Society, Minnesota State Medical Asso-

ciation, Minneapolis Academy of Medicine, Minnesota Academy of Medicine, American Roentgen Ray Society, Radiological Society of North America, Minnesota Radiologic Society, American College of Radiology (fellow), American Association of Thoracic Surgery and the American Association for the Advancement of Science. He is the author of *Outline of Roentgen Diagnosis*, which went into a second edition in 1943, and of many scientific reports. He is active on the Publication Committee for RADIOLOGY.

As long as any of us can remember, Leo Rigler has been doing things for other people. The list is long and impressive. He has arranged and organized departmental conferences with most of the other departments in the hospital, as well as with the preclinical branches. He is always ready and willing to speak at medical gatherings and to teach special courses at the Center for Continuation Study. His contributions to graduate training include not only service to members of his own department but service to practically every other clinical department. He has been instrumental in putting life and vigor into the Minnesota Radiological Society and he has been active in the councils of national associations. In recent years he has made a large contribution to War-Time Graduate Medical Meetings through his visits to all the hospitals in our area. It is at clinical pathological conferences that he is at his best, standing before the group, calling attention to what he sees and giving his conclusions just ahead of the pathologist with his postmortem report. He has been associated with roentgenology during its greatest period of development, and he has made a significant contribution to this specialty.

It is just and fitting that this honor should come to him. The University of Minnesota has been a better place because of his contributions and all of us look forward to profitable years of association with him.

WILLIAM A. O'BRIEN, M.D.
Director of Post Graduate Medical Education
University of Minnesota

AMERICAN COLLEGE OF RADIOLOGY

On Feb. 9, the Commission on Education of the American College of Radiology held a Conference on Post-War Graduate Training for Radiologists, in Chicago. Lt. Comdr. John D. Camp (MC), U.S.N.R., presided, and the speakers were: Victor Johnson, M.D., Secretary, Council on Medical Education and Hospitals, A.M.A.; Lt. Col. Harold C. Lueth, M.C., Liaison Officer, Surgeon General and the American Medical Association; Merrill C. Sosman, M.D., of Boston, and Col. B. R. Kirklin, M.C., Secretary, American Board of Radiology.

MINNESOTA RADIOLOGICAL SOCIETY

The fall meeting of the Minnesota Radiological Society was held at the Nicollet Hotel, Minneapolis, on Dec. 9, 1944. A scientific session occupied the afternoon, with papers on Radiation Therapy of Mastitis, by Dr. Solveig Berg, X-Ray Treatment of Malignant Tumors of the Testis, by Dr. G. M. Kelvey, and Bone Metabolism, by Dr. Edward Flink. The dinner following this session was made the occasion for paying honor to Dr. Leo J. Rigler and for presenting to the University of Minnesota a fund for the establishment of the Leo J. Rigler Lectureship in Radiology. Dr. Fred J. Hodges of the University of Michigan inaugurated the series of lectures, speaking on The Teaching of Radiology. A fuller account of this honor to Doctor Rigler appears on another page.

FRANCIS CARTER WOOD, M.D.

Fifty Years of Service

On Feb. 14, 1945, the Staff of St. Luke's Hospital, New York City, honored Dr. Francis Carter Wood, Director of the Pathological Laboratories and of the Department of Radiotherapy, at a reception, in recognition of his fifty years of service with the hospital. Addresses in praise of Doctor Wood's contributions to medical science were made by Lincoln Cromwell, president of the hospital, who presided; Dr. John Keating, vice-president of the medical board; Dr. John C. A. Gerster, president of the New York City Cancer Committee, and Dr. Oswald Jones, representing the medical alumni of the hospital. Mrs. Robert G. Meade, on behalf of the New York City Cancer Committee, presented Doctor Wood with a beautiful Paul Revere bowl.

A portrait of Doctor Wood, painted by Leonibel Jacobs at the direction of the hospital's board of managers, was unveiled by Mr. Cromwell and will hang permanently in the library of the hospital.

Doctor Wood has long been active in the affairs of the Radiological Society of North America. He was its president in 1932. He delivered the Carman Lecture in 1939 and in the same year was awarded the Gold Medal of the Society. Its members are happy at this further recognition of his outstanding services not only to the hospital with which he has so long been associated but to the broader field of medicine and through it to all mankind.

THREE-YEAR ROTATING SERVICE IN RADIOLOGY

The Peter Bent Brigham Hospital in Boston is announcing a three-year rotating internship and residency in Radiology which began July 1, 1944. The service includes roentgenological training in Pediatrics and Obstetrics under Dr. E. B. D. Neuhauser at the Children's Hospital and Boston Lying-In Hospital, Pathology under Dr. Shields Warren, and Roentgen and Radium Therapy under Dr. Joseph H. Marks, both at the Deaconess Hospital. The initial six months and the final year of the combined service will be spent at the Peter Bent Brigham Hospital under Dr. Merrill Sosman. In individual cases where the candidate has had a thorough training in pathology before starting this service, special arrangements can be made for study and original work in radiation physics, nuclear physics, or biophysics with radioactive tracers, either at Harvard University or Massachusetts Institute of Technology. As soon as Procurement and Assignment will permit, two men will be accepted each year, one each on Jan. 1 and July 1.

This combination of men and of hospital departments should do much to improve the basic training in Radiology and should help insure a continued output of well grounded young roentgenologists, for whom there is such a demand. The plans permit expansion to accommodate returning Service men who may desire shorter periods of training or review in parts of the field, as well as those who wish to complete training previously begun.

In Memoriam

It is with regret that we record the deaths of the following members of the Radiological Society of North America;

JOHN DEAN BOYLAN, M.D.
Milford Center, Ohio
Nov. 19, 1944

RALPH MAURICE DEGRAFF, M.D.
Buffalo, N. Y.
Dec. 13, 1944

HERMAN GUSTAVE MAUL, M.D.
Denver, Col.
Aug. 13, 1944

ARCHIBALD WILLIAM THOMPSON, M.D.
Buffalo, N. Y.
Oct. 22, 1944

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE FOETAL CIRCULATION AND CARDIOVASCULAR SYSTEM, AND THE CHANGES THAT THEY UNDERGO AT BIRTH. By ALFRED E. BARCLAY, O.B.E., D.M., F.R.C.P., F.F.R., F.A.C.R., KENNETH J. FRANKLIN, D.M., F.R.C.P., AND MARJORIE M. L. PRICHARD, M.A., of the Nuffield Institute for Medical Research, Oxford. A volume of 275 pages, with 160 illustrations. Published by Blackwell Scientific Publications, Ltd. 48 Broad Street, Oxford. Price 50/-net.

WHAT ARE COSMIC RAYS? Revised and Enlarged American Edition. By PIERRE AUGUR, Professor at the Ecole Supérieure Normale, France, Research Associate in Physics, University of Chicago, Fellow of the American Physical Society. Translated from the French by Maurice M. Shapiro. A volume of 128 pages, with numerous photographs. Published by The University of Chicago Press, Chicago. Price $2.00.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

Section on Radiology, American Medical Association.—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

ARKANSAS

Arkansas Radiological Society.—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

Los Angeles County Medical Association, Radiological Section.—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

San Diego Roentgen Society.—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

San Francisco Radiological Society.—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

COLORADO

Denver Radiological Club.—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer Charles M. Gray, 306 Citizens Bldg., Tampa 2.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

ILLINOIS

Chicago Roentgen Society.—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

MISSOURI

Radiological Society of Greater Kansas City.—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

St. Louis Society of Radiologists.—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary-Treasurer,* George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.,—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

Central New York Roentgen Ray Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

Rochester Roentgen-ray Society.—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

OHIO

Ohio Radiological Society.—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

The Philadelphia Roentgen Ray Society.—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

The Pittsburgh Roentgen Society.—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Dallas-Fort Worth Roentgen Study Club.—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

Texas Radiological Society.—Secretary-Treasurer, Asa E. Seeds, Baylor Hospital, Dallas.

VIRGINIA

Virginia Radiological Society.—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary-Treasurer. C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave. Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiologia y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

SACHS, MAURICE D., AND SHASKAN, DONALD A. Tuberous Sclerosis 305

PENNYBACKER, JOE. Cholesteatoma of the Petrous Bone 305

GOUGH, C. W. C. Tomography of the Temporo-Mandibular Joint and Ramus of the Mandible 305

WIKLE, HERBERT T., AND SPELLMAN, THOMAS. Foreign Body in the Thyroid Gland 305

The Chest

PEIRCE, CARLETON B., JARRY, G., AND RICHARDSON, ALAN C. Incidence of Pulmonary Tuberculosis in the Royal Canadian Navy 306

MEDLAR, E. M., PESQUERA, G. S., AND ORDWAY, W. H. Comparison of Roentgenograms with the Pathology of Experimental Miliary Pulmonary Tuberculosis in the Rabbit 306

CARDELLE, GUSTAVO, BORGES, FRANCISCO, AND PEREIRAS, RAUL. Massive Pulmonary Atelectasis Occurring During Primary Tuberculous Infection 307

SCOTT, EDWIN P. Pneumonia, Pneumothorax, and Emphysema Following Ingestion of Kerosene 307

TOOMEY, JOHN A., AND PETERSILGE, CARL L. Dust Bronchitis 307

PIRKLE, H. B., AND DAVIN, JULIA R. Loeffler's Syndrome. Transient Pulmonary Infiltrations with Blood Eosinophilia 307

TEMPEL, CARL W. New Growths of the Chest .. 308

ADAMS, W. E., THORNTON, T. F., JR., AND EICHELBERGER, LILLIAN. Cavernous Hemangioma of the Lung (Arteriovenous Fistula). Report of a Case with Successful Treatment by Pneumonectomy 308

BLADES, BRIAN, AND DUGAN, DAVID J. Tuberculoma of the Posterior Mediastinum 309

KERWIN, A. J. Observations on the Heart Size of Natives Living at High Altitudes 309

DELANO, PERCY J., AND WEIHE, ARTHUR R. Cardiac Aneurysm 309

YOUNG, DENNISON, AND SCHWEDEL, JOHN B. Longevity in Ventricular Aneurysm: Report of a Case Followed over a Ten Year Period .. 309

PERLMAN, LAWRENCE. Coarctation of the Aorta: Clinical and Roentgenologic Analysis of Thirteen Cases 310

The Digestive System

MORLOCK, CARL G., AND WALTERS, WALTMAN. Peptic Ulcer Perforating Into the Anterior Abdominal Wall 310

HERSTONE, SAMUEL T., AND FREUND, SEELIG. The Normal Distribution of the Small Intestine 310

KHOO, F. Y., LIU, K. S., AND CH'EN, K. H. Roentgenological Anatomy of the Position of the Coils of the Normal Small Intestine 311

ERB, WILLIAM H., AND SMITH, DELBERT C. Atresia of Small Intestine. Two Case Reports; One Multiple Atresia with Survival 311

HENDERSON, N. P. Diverticulitis and Diverticulosis 311

OCHSNER, HAROLD C. Cholecystography with Beta(4-Hydroxy-3,5-Diiodophenyl) Alpha Phenyl Propionic Acid 311

PRATT-THOMAS, H. R. Aneurysm of the Abdominal Aorta with Rupture into Duodenum. Report of Three Cases 311

The Skeletal System

BRECK, LOUIS W., HILLSMAN, J. WINSTON, AND BASOM, W. COMPERE. Lumbosacral Roentgenograms of 450 Consecutive Applicants for Heavy Work 312

EXPÓSITO, LORENZO AND DE FERIA, ARGELIO. Lipochondrodystrophia 312

PECK, FRANKLIN B., AND SAGE, CHARLES V. Diabetes Mellitus Associated with Albright's Syndrome (Osteitis Fibrosa Disseminata, Areas of Skin Pigmentation, and Endocrine Dysfunction with Precocious Puberty in Females) 312

FRENCH, J. DOUGLAS, AND PAYNE, J. T. Cauda Equina Compression Syndrome with Herniated Nucleus Pulposus. A Report of Eight Cases 313

TRUOG, C. P. "Ring" Sequestra as a Complication of Fixed Skeletal Traction 313

ALLAN, JOHN H., AND NICHOLSON, JESSE T. Knee Injuries in Service Personnel 313

ABBOTT, LEROY C., SAUNDERS, JOHN B. DE C., BOST, FREDERIC C., AND ANDERSON, CARL E., Injuries to the Ligaments of the Knee Joint .. 314

HURT, FLOYD, AND FLO, SPENCER C. Traumatic Synostosis of the Distal Third of the Radius and Ulna 314

ROBIN, PERCIVAL A., AND THOMPSON, SAMUEL B. Fatigue Fractures 314

PLEWES, L. W., AND MCKELVEY, K. G. Subtalar Dislocation 314

GOOD, C. ALLEN, ADSON, ALFRED W., AND ABBOTT, KENNETH H. Spinal Extradural Cyst (Diverticulum of the Spinal Arachnoid) 314

Gynecology and Obstetrics

SCHWARTZ, FREDERICK L. Salpingitis and Tubal Patency 315

The Genito-Urinary Tract

MOORE, NEIL S., AND MCCARTHY, HARRY H. Perirenal Abscess with Extension into the Right Pleural Cavity Following Rupture of

Right Renal Pelvis: Operative Findings and Results..... 315
MATHÉ, CHARLES P. Actinomycosis of the Kidney; Report of a Primary Case..... 315

RADIOTHERAPY

Neoplasms

SOMERVELL, T. H. Recent Advances in the Treatment of Carcinoma of the Mouth and Jaws.. 316
MORTON, J., GRAY, L. H., AND NEARY, G. J. A Consideration of Dose Distributions in the Treatment of Intrinsic Carcinoma of the Larynx by Radium Implantation..... 316
PUENTE DUANY, N., AND CASTELLANOS, A. Thymic Region Tumors with Acute Leukemia.. 317
MATTICK, WALTER L. Some Experiences in the Treatment of Bronchial Cancer..... 317
BURCH, HOBART A. Osseous Metastases from Graded Cancers of the Breast, with Particular Reference to Roentgen Treatment..... 317

Non-Neoplastic Conditions

CROWE, S. J. Local Use of Sulfadiazine Solution, Radon, Tyrothricin, and Penicillin in Otolaryngology..... 318
RENTSCHLER, HENRY D., AND SETTLE, JOHN W., JR. Treatment of Impaired Hearing by Radiation of Excessive Lymphoid Tissue in the Nasopharynx..... 318

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Tuberous Sclerosis. Maurice D. Sachs and Donald A. Shaskan. Am. J. Roentgenol. **52:** 35–39, July 1944.

Tuberous sclerosis is a rare hereditary disease of ectodermal origin. Cardinal symptoms are (1) retarded mental development; (2) epileptic seizures; (3) adenoma sebaceum; (4) nodules in the brain with a tendency toward cotton ball calcification, and (5) phacoma of the retina. There may be, also, multiple skin nodules similar to those of neurofibromatosis, periungual tumors, rhabdomyoma of the heart, tumors of visceral organs, and high and narrow or cleft palate. The patient seeks medical advice chiefly because of epileptic seizures. These generally have their onset in the first year of life. Mental deterioration is progressive. There is a symmetrical butterfly distribution of small warty tumors over the nose, cheeks, and chin. Tumors of the retina appear as small, flat, round, white or yellowish spots on the posterior fundus near the papilla.

Roentgenologically, multiple circular nodules of increased density with varying degrees of calcification are seen throughout the brain. Pneumo-encephalograms may reveal the classical "candle guttering or dripping" as a result of indentation of the ventricular system by the nodules. Hydrocephalus may be a pertinent finding. Erosions of the clinoid processes and sphenoid wings as well as hyperostosis interna have been reported. Cysts in the spongiosa of small bones have been described. Renal tumors are common. Polyposis of the colon may also be present.

The diagnosis of tuberous sclerosis should be considered in every patient with mental retardation and epilepsy, especially in association with adenoma sebaceum. The authors present a case with many of the findings described in the text.

CLARENCE E. WEAVER, M.D.

Cholesteatoma of the Petrous Bone. Joe Pennybacker. Brit. J. Surg. **32:** 75–78, July 1944.

Progressive paralysis of the facial nerve may be caused by a tumor in the cerebellopontine angle or by pressure on the nerve in its course through the petrous bone. Three cases of the latter type are reported in which the pressure was found to be due to a cholesteatoma in the petrous bone.

The first patient was a man aged 42 with a complete right facial paralysis developing over a period of eighteen months. There was impairment of sense of taste on the right side and the patient was very deaf in the right ear. The caloric responses were absent on the right side and normal on the left. Roentgenograms of the skull showed an erosion of the upper surface of the petrous bone medial to the mastoid antrum. The mastoid air cells were of about normal translucency. At operation an irregularly oval erosion in the petrous bone anterior to the arcuate eminence was found. The defect was filled with a soft cheesy white material. The facial nerve was exposed and found to be intact but flattened. The patient was observed for two and a half years following operation and there had been no improvement in the facial palsy or deafness.

The second case was in a man of sixty who had had a discharging left ear in childhood with resulting deafness in that ear, although there had been no recurrence of the discharge. Gross spasmodic contractions of the left facial musculature began one year before hospital admission, and complete facial paralysis occurred three months before. The radiologic findings were similar to those in the first case and a similar lesion was found at operation. After six months there was definite evidence of recovery and this had continued until the patient was able to innervate the whole of the left side of his face.

The third patient was a man of 53 with a facial palsy of four years' duration. He gave a history of otitis media twenty-five years before, followed by complete recovery. Roentgenograms showed an erosion of the superior surface of the petrous bone. The neurological findings were similar to those of the other two cases, and at operation a similar lesion was found. Recovery was not considered likely in this case.

These three cases present many common features. In each there were deafness of the homolateral ear, absence of caloric responses, and impairment of the sense of taste. Roentgenographic and pathological findings were the same in all. The gross and microscopic pathological findings were characteristic of cholesteatoma.

Jefferson and Smalley (J. Laryng. & Otol. **53:**417, 1938) reported 6 similar cases and found references to 5 others in the literature of the previous twenty-five years. They considered the tumors to be epidermoids of the embryonal inclusion type rather than the cholesteatoma often associated with chronic mastoid infection. In at least 2 of their cases there had never been any aural infection, and in the others the infection was remote and trivial in degree. The question whether cholesteatoma causes infection of the middle ear and mastoid or is itself the product of chronic inflammation has not been answered at this time.

The best chance for recovery in these cases rests in early operation and subsequent electrical treatment.

MAX CLIMAN, M.D.

Tomography of the Temporo-Mandibular Joint and Ramus of the Mandible. C. W. C. Gough. Brit. J. Radiol. **17:** 213–215, July 1944.

Tomography is the only method of showing the temporomandibular joint and the ramus of the mandible without distortion. It is particularly useful to the plastic surgeon in congenital facial asymmetry, fibrous and bony ankylosis, and in traumatic lesions. Brief case reports are included, with illustrations.

SYDNEY J. HAWLEY, M.D.

Foreign Body in the Thyroid Gland. Herbert T. Wikle and Thomas Spellman. Surgery **15:** 994–996, June 1944.

The authors report a case of foreign body in the thyroid gland present for a long period without causing any reaction that could be specifically referred to it. The patient, a 38-year-old white woman, complained of a tumor of the anterior portion of the neck first observed at the age of twelve. This was twice operated upon when the patient was fifteen. Some diminution in size followed, but five years later the growth began

to enlarge and had continued to do so until the present admission (1938).

The patient complained of moderate orthopnea and dyspnea on exertion. There were no symptoms of thyrotoxicosis or exophthalmos. A large thyroid tumor, the size of a grapefruit, filled the entire anterior part of the neck and extended on both sides into the posterior triangle. The tumor was firm and showed several nodules. There was slight cardiac enlargement and a loud systolic murmur. The basal metabolic rate was plus 13 and the electrocardiogram was essentially negative. A roentgenogram showed the lungs to be clear and the cardiac enlargement was interpreted as hypertrophy and dilatation.

A lateral examination of the neck showed a large soft-tissue opacity in front of the trachea, measuring 8 cm. in the antero-posterior diameter and 14.5 cm. in transverse diameter. A few small specks of greater density scattered throughout the mass were believed to represent cartilaginous change.

Six days after admission a subtotal thyroidectomy was performed. A large amount of scar tissue was encountered on both sides, adjacent to the previous operative scars. A portion of the left lobe was found to extend retrosternally. After this was delivered into the wound a sharp object was palpated in the fascia, just below the suprasternal notch. This was removed and found to be an old cutting edge needle in two parts, the major one 1.5 cm. in length. It is interesting to note that the needle was discovered just below the suprasternal notch, yet the two operative scars were in the mid portion of the neck on either side.

J. E. WHITELEATHER, M.D.

THE CHEST

Incidence of Pulmonary Tuberculosis in the Royal Canadian Navy. Carleton B. Peirce, G. Jarry, and Alan C. Richardson. Canad. M. A. J. **51:** 46–51, July 1944.

As an assay of the effectiveness of the "screening" methods in use, and to determine, if possible, the influence of service conditions, a survey was made of tuberculosis in the Canadian Naval Service from September 1939 to December 1943. Of 82,946 recruits examined in this period, 8,398 (10.1 per cent) were rejected for all causes. Pulmonary tuberculosis accounted for 439 rejections, 0.53 per cent of the total number examined and 5.2 per cent of all those rejected. The number of cases of tuberculosis discovered in the Naval Service during this same interval was 151, or 0.8 per thousand per year, an over-all rate of 2 per thousand, since the total naval strength was 75,354 (as of Jan. 1, 1944). The greatest incidence was in the first two years, due probably to incompleteness of the radiographic survey prior to the institution of compulsory mass radiography.

On an occupational basis, the incidence was highest among writers and supply ratings (19 cases, or 7.4 per 1,000) and cooks and stewards (17 cases, or 4.6 per 1,000). The engine room personnel showed a rate almost double that of those on deck, 2.9 per 1,000 compared with 1.7 per 1,000.

The highest rate of discharge for tuberculosis was in the second year of service, but in men on sea duty the incidence of the disease increased with the length of service at sea.

Only two deaths occurred in this series, both from meningitis. Analysis shows that 62 per cent of the 151 cases were detected when the lesions were minimal or sub-minimal, 31 per cent when moderately advanced, and 7 per cent when far advanced. Twenty-one per cent of the series were under twenty years of age and 45 per cent were between twenty-one and twenty-five years.

Pulmonary tuberculosis had been the sixth cause for invaliding from the service up until January 1944. It is exceeded by mental and nervous disorders, eye diseases, peptic ulcers, and respiratory infections other than tuberculosis.

The authors state a preference for the use of conventional 14 × 17-in. film in mass chest surveys. They believe that accuracy in interpretation and the availability of a large film for future possible comparative examination outweigh the economy of cost and filing space afforded by miniature films.

LESTER M. J. FREEDMAN, M.D.

Comparison of Roentgenograms with the Pathology of Experimental Miliary Pulmonary Tuberculosis in the Rabbit. E. M. Medlar, G. S. Pesquera, and W. H. Ordway. Am. Rev. Tuberc. **50:** 1–23, July 1944.

It has been shown previously that miliary tuberculosis in the rabbit can be produced consistently by intravenous injection of bovine bacilli. The number of lesions can be controlled to some extent by the number of bacilli injected. The course of the infection depends upon whether virulent or non-virulent strains have been used, whether or not the animals are vaccinated, and whether a large or small dosage of virulent bacilli is given. With this knowledge at hand, the series of experiments reported in this paper was undertaken, in order to make a comparative study of the pathological findings and of roentgenograms of the thorax and of inflated excised lungs in miliary pulmonary tuberculosis.

As would be expected, the extent and essential nature of the pathological lesions were best determined by microscopic examination. To a lesser degree the pathological findings were demonstrable in macroscopic examination, roentgenograms of the excised lungs, and, lastly, roentgenograms of the thorax of the living animal. The latter failed to distinguish between primary infections with virulent and non-virulent bacilli or between primary infection and reinfection with virulent bacilli. In general the various types of pathological processes could not be differentiated roentgenographically in the excised lungs except for compact calcium deposits. Lesser amounts of calcium within caseous foci could not be differentiated from the caseous material. Superimposition of lesions caused a density in shadows which masked their true nature. Compactness rather than size appeared to be the determining factor as to whether a given lesion could be visualized, and the compact lesion needed to be equal to at least the volume of a primary lobule before a shadow would be cast in roentgenograms of the excised lung. It would appear that considerably larger areas of compact, inflammatory exudate would be necessary before their shadows could be seen in roentgenograms of the thorax.

If these facts are applicable to the human chest, it is probable that the earliest demonstrable tuberculous focus would be a compact area of tuberculous bronchopneumonia.

L. W. PAUL, M. D.

Massive Pulmonary Atelectasis Occurring During Primary Tuberculous Infection. Gustavo Cardelle, Francisco Borges, and Raul Pereiras. Bol. Soc. cubana de pediat. **16:** 85–93, March 1944.

A case of massive pulmonary atelectasis developing in a child with primary tuberculosis is reported.

The patient, a nineteen-month-old boy of healthy parents, but with a tuberculous grandmother, had frequent colds, cervical adenitis, otitis, and tonsillitis. Complaints on admission were continued temperature rise, cough, and dyspnea. The child was poorly nourished but showed no signs of serious illness.

The cervical lymph nodes were very large, and the axillary and inguinal nodes also showed some enlargement. X-ray examination revealed massive collapse of the left lung, as well as enlarged mediastinal nodes. Bronchoscopic examination showed the mucosa in the left bronchus to be inflamed, with much thick yellow phlegm obstructing the lumen.

In discussing the differential diagnosis, the authors state that the condition offering the greatest difficulty is fibrosis, in which the lung is retracted and the mediastinum is displaced to the affected side. Pneumothorax and fluoroscopy are important aids.

The value of artificial pneumothorax in the treatment of this type of atelectasis is stressed.

A. MAYORAL, M.D.

Pneumonia, Pneumothorax, and Emphysema Following Ingestion of Kerosene. Edwin Paul Scott. J. Pediat. **25:** 31–34, July 1944.

Pulmonary manifestations following the accidental ingestion of kerosene are rather common in young children. In the case reported, pneumonia, pneumothorax, and emphysema of the soft tissues of the chest were the complicating factors.

A 2-year-old child was admitted to the hospital in a comatose condition about two hours after the ingestion of 1 to 2 ounces of kerosene. Numerous moist râles were heard throughout the lung fields, with no demonstrable change in the percussion note. The abdomen showed considerable distention. The rectal temperature was 99.6° F., with a respiratory rate of 48 per minute. The patient responded well to treatment and the following morning was alert and ate well. In view of an elevation of the temperature to 103.2° and an increased white blood cell count, sulfathiazole was administered. Two days later the temperature became normal. At this time examination of the chest revealed emphysema of the soft tissues of the neck and chest and numerous fine crepitant râles throughout the lung fields. Roentgen studies the following day showed a left pneumothorax with partial collapse of the left lower lobe. The entire left lung showed a dense, patchy, hazy process, especially pronounced in the lower lobe. On the right there was an irregular haze except in the cardiophrenic sinus, where consolidation was present. Overlying this region was an area of decreased density which measured 3 cm. and apparently represented a fluid level. The heart was slightly enlarged and displaced to the right. An extensive soft-tissue emphysema was present over the upper abdomen and thorax, extending to the neck and face.

The pneumothorax gradually cleared and the emphysema disappeared. Two weeks following the accident, the physical and roentgen examinations were normal.

Dust Bronchitis. John A. Toomey and Carl L. Petersilge. J. Pediat. **25:** 25–30, July 1944.

A type of bronchitis associated with prolonged exposure to high concentrations of dust, having none of the characteristics of an infectious disease, is described. This bronchitis was correlated with sparsity of rainfall.

During 1941 and 1942, 63 children with coughs were admitted to the infirmary of an orphanage. The patients were healthy and apparently normal. Often the first sign of dust bronchitis was an explosive, intractable, unproductive cough. Subjectively the only complaint was an uncomfortable tickling sensation in the throat accompanied by an uncontrollable cough which was aggravated by excitement or by lying on the back. Objectively the patient was comfortable unless activated in some manner. Coughing, once initiated, was severe, sometimes to the point of vomiting. The temperature was slightly elevated, *i.e.*, about 101° F., returning to normal after twenty-four to forty-eight hours' rest in bed.

Inspection, percussion, and palpation of the chest revealed nothing abnormal. On auscultation, loud rhonchi were heard, most commonly over the large bronchi, particularly over the bases, predominating on the left. There were wheezing and whistling noises in the chest, but there were no modifications of inspiratory or expiratory sounds and no fine parenchymatous râles. A deep breath often initiated a coughing spell.

Thirteen of the 63 children had roentgen studies of the chest. The composite picture was described as follows: "There were soft-appearing patchy mottling with increased markings along the course of the bronchi, usually the descending ones. Ulceration, calcification, retraction, or emphysema were not present. The shadows looked not unlike those found in bronchiolitis obliterans, except that the mottling was coarser. This might have been due to the fact that in these children the larger bronchi were involved. The lungs showed no other changes."

Treatment is prophylactic and symptomatic, the former being the most important.

Loeffler's Syndrome. Transient Pulmonary Infiltrations with Blood Eosinophilia. H. B. Pirkle and Julia R. Davin. Am. Rev. Tuberc. **50:** 48–51, July 1944.

Löffler's syndrome (Löffler, W.: Beitr. z. Klin. d. Tuberk. **79:** 338, 1932) consists of asthma with cough, eosinophilia ranging from 10 to 60 per cent, low-grade fever, mild leukocytosis and an elevated sedimentation rate. Roentgenograms of the chest reveal infiltrations in various parts of the lungs, usually the lower, which disappear rapidly.

A case is presented which differs from others reported in the literature in that there was no asthma and the pulmonary infiltrations were of long duration and migratory in character. The clinical course and the roentgen evidence of disease lasted over a period of nine months, during which time pulmonary infiltrations of varying extent developed. The lesions tended to clear in some areas only to reappear in other parts of the lung fields. The eosinophil count reached as high as 33 per cent. The diagnosis of pulmonary tuberculosis was made at the first examination, but further study eliminated this possibility and likewise failed to establish any other etiologic agent.

L. W. PAUL, M.D.

New Growths of the Chest. Carl W. Tempel. Dis. of Chest **10:** 277–312, July–August 1944.

The author presents his material under four headings. In the introduction he stresses the need of close co-operation on the part of the internist, endoscopist, roentgenologist, pathologist, and surgeon, in the diagnosis and treatment of new growths of the chest. Part two is devoted to classification, and part three to diagnostic criteria, including pathological and roentgen studies, therapeutic doses of roentgen radiation, bronchoscopy and esophagoscopy, surgical exploration, laboratory tests, thoracoscopy, symptoms and signs of diagnostic importance. Part four consists of case histories with illustrations.

The main subdivisions of the author's classification aer as follows.

1. Tumors of the large or major bronchi
   - A. Carcinomas: squamous-cell and small-cell types
   - B. Adenomas (mixed tumors)
2. Tumors of minor bronchi or periphery of the lung
   - A. Adenocarcinoma
   - B. Superior pulmonary sulcus tumor
3. Anterior mediastinal tumors
   - A. Malignant lymphomas: lymphosarcoma; Hodgkin's disease; leukemia; giant follicular lymphocytoma
   - B. Thymomas
   - C. Teratoid tumors
   - D. Cysts
4. Posterior mediastinal tumors: Primary neuromas
5. Rare mediastinal tumors
   - A. Fibroma and sarcoma
   - B. Carcinoma
   - C. Tumors arising from bone and cartilage
   - D. Intrathoracic cysts of intestinal structures and intrathoracic stomach
   - E. Lipomas
   - F. Xanthomas
6. Tumors originating in chest wall
   - A. Benign tumors
   - B. Malignant tumors
   - C. Tumors of pleura
7. Non-neoplastic lesions, which may be confused with new growths
   - A. Cysts: congenital; developmental; acquired inflammatory; echinococcic
   - B. Circumscribed inflammatory masses within the lung
   - C. Lymph node enlargement: solid or abscessed masses of tuberculous hilar or mediastinal lymph nodes; Boeck's sarcoid; benign enlargement of unknown etiology
   - D. Atelectasis of a lobe or part of a lobe
   - E. Aneurysms of the great vessels and heart
   - F. Lesions of the diaphragm
   - G. Mega-esophagus
   - H. Encapsulated empyema
   - I. Abscess: mediastinal and Pott's
   - J. Mediastinal thyroids

For diagnostic purposes, all available chest films should be reviewed, and stereoscopic, lateral, and oblique roentgenograms should be made. Most circumscribed intrapulmonary neoplasms are bronchiogenic carcinomas; circumscribed extrapulmonary tumors in the costovertebral region are usually neurofibromas, and in the anterior chest, teratomas. Most neoplasms that are not well circumscribed are malignant, but the loss of sharp definition at the edge of the tumor may be due to inflammatory changes or atelectasis in the adjacent lung.

The x-ray findings in the majority of bronchiogenic tumors are those of atelectasis or other secondary changes. If a large bronchus is partially obstructed, the lung involved becomes less radiant and is likely to show linear areas of increased density. In the presence of complete obstruction of a secondary bronchus, the collapsed portion of the lung usually appears as a dense triangular area along the diaphragm, heart, and spine. With complete occlusion of the right or left main bronchus, the entire half of the chest is extremely dense; the mediastinum is displaced into the involved lung field; the intercostal spaces are narrowed, and the diaphragm is elevated.

Diagnostic pneumothorax may aid in distinguishing between tumors of the lung, mediastinum, and thoracic wall. Pneumoperitoneum is of value in differentiating supradiaphragmatic from subdiaphragmatic lesions.

Bronchography with the aid of lipiodol may be used to demonstrate the level and extent of the bronchial occlusion, as well as the condition of the lung beyond the tumor.

Fluoroscopy is of value to determine whether a mass is expansile, as an aneurysm; as an aid in localization of the tumor, and in disclosing its relation to the diaphragm. Tumors in the lower part of the chest not in continuity with the diaphragm will usually descend with the lung during inspiration if they are intrapulmonary. If the diaphragm is paralyzed, it usually means that the phrenic nerve is involved and the case is inoperable.

A favorable response to a therapeutic dose of x-rays indicates the probable presence of a lymphoblastoma.

If it is suspected that the pulmonary tumor is metastatic, appropriate x-ray studies should be undertaken to determine the primary site.

HENRY K. TAYLOR, M.D.

Cavernous Hemangioma of the Lung (Arteriovenous Fistula). Report of a Case with Successful Treatment by Pneumonectomy. W. E. Adams, T. F. Thornton, Jr., and Lillian Eichelberger. Arch. Surg. **49:** 51–58, July 1944.

Cavernous hemangioma of the lung is a rare condition; its association with polycythemia has previously been reported only four times. In this instance a man of twenty-four complained of frequent nosebleeds and colds over a period of two or three years. For at least sixteen years he had a generalized cyanosis and clubbing of the fingers, which were first observed following an attack of influenza at the age of six. He had nevertheless been able to work as a farm laborer. Examination showed an arresting degree of cyanosis, clubbing of the fingers and toes, and small hemangiomas of the lips and face. Breath sounds were somewhat diminished over the whole chest. Other findings were normal. The red cell count was 7,200,000; hemoglobin 23 gm. per 100 c.c. The total blood volume was 12,750 c.c., of which 10,330 c.c. were cells. The vital capacity of the lungs was 3,800 c.c.

Roentgenograms of the chest showed a lobulated shadow covering 25 sq. cm. between the left seventh and

ninth ribs posteriorly. A similar area of density, 1 cm. in diameter, was present in the right mid-axillary line at the level of the sixth rib. The extremities showed deposition of periosteal new bone.

A successful removal of the left lung was performed. One lesion was found to consist of a multiloculated, smoothly lined cavity 3 × 4 cm., which communicated with the pulmonary artery by a vessel 0.5 cm. in diameter and with the vein by one 1 cm. in diameter; two other similar lesions were present in this lung. Microscopic study showed a mesothelial lining on a fibrous connective-tissue wall; there was no hemangiomatous tissue outside the cavities. The pathological diagnosis was multiple arteriovenous fistulas of the lung. Following operation the red cell count fell to 5,000,500 and the hemoglobin to 15.5 gm. per 100 c.c. The blood volume decreased to 6,900 c.c., 4,250 c.c. of which were cells. Other laboratory findings also tended to become more normal. The patient was alive, well, and doing his work for a period of nine months of observation.

While this condition is easily confused clinically with polycythemia vera, clubbing of the fingers and toes should suggest the advisability of a roentgenogram of the chest, which will lead to the correct diagnosis. LEWIS G. JACOBS, M.D.

Tuberculoma of the Posterior Mediastinum. Brian Blades and David J. Dugan. Am. Rev. Tuberc. **50:** 41–47, July 1944.

An occasional case has been reported in the literature in which a tuberculous or other inflammatory lesion of the lung has been mistaken for tumor and the error discovered only after surgical intervention. These cases represent exceptions, for the great majority of intrapulmonary masses demonstrable on roentgenograms, which cannot be identified by ordinary methods, will prove to be malignant or potentially malignant neoplasms.

A 56-year-old white male complained of slight dyspnea on exertion. Roentgen study disclosed a circumscribed mass in the posterior mediastinum behind the heart. After study, the diagnosis of primary nerve tumor was made and operation was undertaken. The mass was well encapsulated and could be removed without difficulty. Microscopic examination showed the lesion to be a tuberculoma. The patient made an uneventful recovery. This diagnosis had not been considered prior to the examination of the tissue. The results indicate that such an error in diagnosis may be less harmful to the patient than procrastination when dealing with intrathoracic tumors of unknown nature, and that removal of a well encapsulated tuberculous lesion need not be followed by dissemination of the disease. L. W. PAUL, M.D.

Observations on the Heart Size of Natives Living at High Altitudes. A. J. Kerwin. Am. Heart J. **28:** 69–80, July 1944.

In order to determine the effects of chronic anoxia on the heart, roentgenographic examinations were made of 273 normal native Peruvian males of the Indian race. Their average height was 156.26 cm., and their average weight was 55.63 kg. All were born at altitudes varying from 10,000 to 15,000 feet and, with few exceptions, had lived all their lives at these altitudes.

The transverse, long, and broad diameters were measured, and the frontal area was estimated from the long and broad diameters by means of the nomogram of Ungerleider and Gubner (Am. Heart J. **24:** 494, 1942, Abst. in Radiology **40:** 528, 1943). The estimate of the effect of altitude on heart size was based on the transverse diameter and the frontal area.

The author found that the transverse diameters of the natives were greater than the normal standards for white males in all age groups living at low altitudes, the average difference being +11.5 per cent. The frontal area showed an average increase of 16.3 per cent over the normal for men living at or near sea level. The author believes that chronic anoxia is a reasonable explanation for the increase in the frontal area and the transverse diameter of the heart.

HENRY K. TAYLOR, M.D.

Cardiac Aneurysm. Percy J. Delano and Arthur R. Weihe. Am. J. Roentgenol. **52:** 31–34, July 1944.

Almost all cardiac aneurysms are due to coronary thrombosis; among the other very occasional causes must be listed abscess of the cardiac wall, trauma, ulcerative endocardial lesions, and congenital lesions. Cardiac aneurysm may be found as early as six weeks after a coronary occlusion. The usual sequence of events appears to be anemic necrosis and myomalacia, followed by fibrosis. About 85 per cent of these aneurysms occur in the left ventricle; 2 to 5 per cent of them are in the right ventricle. Some are found in the interventricular septum. About 80 per cent occur in males. Syphilis plays a minor role. Rupture of a cardiac aneurysm is rare.

The postero-anterior roentgenogram of the chest gives adequate information in many instances, since most of the aneurysms are situated in the left ventricle. Aneurysms involving the cardiac apex may be elusive unless care is taken to examine this area well in deep inspiration. Roentgenoscopy should be employed. Paradoxical motion in the aneurysmal sac is not a reliable sign as it is often absent. Aneurysms in the apex have a tendency to develop downward.

Death is usually due to another attack of coronary thrombosis. The average life expectancy is a little less than two years.

The authors describe one case of aneurysm of the left ventricle, discovered during examination of the gastro-intestinal tract. The cause was coronary thrombosis. CLARENCE E. WEAVER, M.D.

Longevity in Ventricular Aneurysm: Report of a Case Followed over a Ten Year Period. Dennison Young and John B. Schwedel. Ann. Int. Med. **21:** 141–149, July 1944.

It is most unusual for a person with a progressively enlarging aneurysm of the left ventricle to continue his daily activity and maintain himself as a useful, productive member of society for a period of ten years, as happened in the case here recorded. The patient was closely followed over this period, clinically, radiographically, and electrocardiographically.

Four months before the patient was seen he began to experience episodes of pain in the epigastrium, chest, and in both upper extremities, with dyspnea, and nausea, following exertion. The attacks became more frequent and severe in character. On first examination (Sept. 24, 1931) the picture of shock was present. The heart was not enlarged to percussion; the first apical sound was faint and a pericardial friction rub was present. The white blood cell count was 18,000,

with 89 per cent polymorphonuclear leukocytes. The electrocardiogram was that of anterior wall infarction.

Roentgen examination on Oct. 13, 1931, revealed an enlargement of the heart to the right and left with a prominence at the mid portion of the left border suggesting the presence of a ventricular bulge. Ten days later this prominence had increased in size. The patient was discharged improved on Nov. 29.

On Jan. 27, 1932, the patient was admitted to Montefiore Hospital. On fluoroscopy the left ventricle was seen to be greatly enlarged and its pulsations were poor. An angular bulge was noted in its upper middle contour. The left auricle was enlarged horizontally. Moderate enlargement of both the outflow and inflow tracts of the right ventricle was present. Four months later there was further enlargement of the left ventricle, especially in the region of the aneurysmal bulge. In the left anterior oblique view an area of increased density was seen to occupy most of the posterior left ventricular contour. This increased density was believed to be due to an organized thrombus within the aneurysmal bulge.

Four months later the patient was again discharged as improved, and for the next nine years he was observed frequently in the adult cardiac clinic. Throughout this period he continued his occupation as a machine operator, working thirty-five hours a week. Symptoms of congestive heart failure reappeared in 1941, and on Sept. 8, 1941, acute severe colicky pain occurred in the right upper quadrant just above and to the right of the umbilicus. The liver enlarged progressively; sibilant râles were heard throughout the lungs, and death ensued (Sept. 10).

Throughout the nine years of observation at Montefiore Hospital, radiographic examination demonstrated progressive enlargement of the ventricular aneurysm.

The autopsy diagnosis was a hypertrophy and dilatation of the heart with arteriosclerosis of the aorta. An extensive arteriosclerosis of the coronary arteries with old occlusion of the left anterior descending and right main coronary arteries, and marked narrowing of the circumflex branch of the left coronary artery, was found. An old healed infarct of the septum and anterior and posterior walls of the left ventricle, with aneurysmal dilatation and mural thrombus formation involving the anterior, lateral, and posterior walls of this chamber, was present.

The aneurysmal bulge involved most of the anterior wall of the left ventricle, the greater part of the interventricular septum, and slightly less than the lower half of the posterior wall, mostly laterally. It measured $10 \times 8 \times 7$ cm. and was filled with firm lamellated brown and brownish-red thrombus. The entire left ventricular chamber was markedly dilated.

STEPHEN N. TAGER, M.D.

Coarctation of the Aorta: Clinical and Roentgenologic Analysis of Thirteen Cases. Lawrence Perlman. Am. Heart J. **28:** 24–38, July 1944.

Coarctation of the aorta is a congenital anomaly. It may be of the infantile type, occurring in children up to the age of one year, or of the adult type. Routine physical examinations of an unselected group of men for army service showed an incidence of 1:10,000, though postmortem statistics have shown an incidence of 1:1,500 (Blackford: Arch. Int. Med. **41:** 702, 1928). The discrepancy is attributed to the inclusion of slight narrowing at the site of the ductus arteriosus by the pathologists in their series, and also to missed clinical diagnoses.

The roentgen examination is a definite aid in diagnosis, the usual findings being absence of the aortic knob, dilatation of the ascending and transverse portions of the aortic arch, erosion of the lower margin of the posterior portions of the ribs, and roundness or enlargement of the left ventricle. In the author's series of 13 cases, absence of the aortic knob and erosion of the ribs were the only constant radiologic findings. In 10 instances the aorta was either slightly or moderately dilated, and in 3 there was no dilatation. Left ventricular hypertrophy was slight in 5, moderate in 3, marked in 1, and absent in 4. Electrocardiograms were made in 7 cases: 5 were normal, and in 2 the findings were compatible with hypertensive heart disease.

HENRY K. TAYLOR, M.D.

THE DIGESTIVE SYSTEM

Peptic Ulcer Perforating Into the Anterior Abdominal Wall. Carl G. Morlock and Waltman Walters. Am. J. Surg. **65:** 133–137, July 1944.

Three cases are reported of a benign peptic ulcer occurring at the stoma of an anterior gastrojejunostomy. These ulcers became attached to and burrowed deeply into the abdominal wall. In order to attach itself to the anterior abdominal wall and secondarily penetrate it, the ulcer must have its origin in a part of the wall of the stomach adjacent to that of the abdomen. A gastrojejunal ulcer arising on the anterior rim of an anterior gastrojejunal stoma is, therefore, peculiarly likely to result in this complication. When it occurs, it must be treated surgically. For a gastric ulcer to originate in the anterior gastric wall and penetrate into the abdominal wall is exceedingly rare in a stomach which has not been previously disturbed by operation.

The Normal Distribution of the Small Intestine Samuel T. Herstone and Seelig Freund. Am. J. Roentgenol. **52:** 46–51, July 1944.

The authors reviewed the work and results obtained by various investigators of the problem of the normal distribution of the small intestine and found no general agreement. This paper reports a re-investigation of the subject.

Fifty-four cadavers were studied. The habitus of each was determined by tracings of the subcostal angle. The abdomen was divided into five regions; right and left upper quadrants, right and left lower quadrants, and minor pelvis. A loop of small intestine was selected at random from each of the five regions and was identified by tying a colored ligature about it, a different color being used for each region. In five of the cadavers all the loops in each region were identified by colored strings. Schematic drawings of the configuration of the small bowel with particular reference to the five regions were made. The distance of each colored ligature from the duodenojejunal flexure was determined. Five types of grouping of the small intestine loops were found and are described in the text and illustrated by line drawings. No relationship was found between various groups and habitus. The total length of the bowel varied from 10 to 30 feet. The distance of the various colored strings from the duodenojejunal junction showed great variation. For example, the red string, which signified the left lower quadrant, was found to be 2 feet 6 inches from the

duodenojejunal junction in one cadaver and 15 feet from the same point in another. Loops were found lying together which in the outstretched gut were as much as 20 feet apart.

The conclusion is reached that, although definite patterns and groups are recognizable in a study of the small intestine, these are not sufficiently constant to be of any clinical value. It is impossible to predict the distance of a loop from the duodenojejunal junction by its location in the abdomen.

CLARENCE E. WEAVER, M.D.

Roentgenological Anatomy of the Position of the Coils of the Normal Small Intestine. F. Y. Khoo, K. S. Liu, and K. H. Ch'en. Chinese M. J. **62:** 61–82, January–March 1944.

The authors studied the small intestinal pattern of 444 adults, employing a barium meal, and recording the findings from serial fluoroscopic and radiographic observations. They conclude that, with the exception of a relatively constant location for the proximal jejunum and distal ileum, the position of the middle loops of the small gut is so variable that it is not feasible to allocate certain groups specific positions. Their studies also confirm the changeability of the intestinal pattern as seen in the same subject on different days.

ELLWOOD W. GODFREY, M.D.

Atresia of Small Intestine. Two Case Reports; One Multiple Atresia, with Survival. William H. Erb and Delbert C. Smith. Ann. Surg. **120:** 66–72, July 1944.

The authors briefly review the literature and report two additional cases of atresia of the small intestine. This condition is relatively rare, occurring but once in every 20,000 births (Webb and Wangensteen. Am. J. Dis. Child. **41:** 262, 1931). It results from a failure of recanalization of the intestinal tract following the obliteration of the original lumen by epithelial concrescences between the fifth and tenth week of fetal life.

The most valuable laboratory test is a plain film of the abdomen. Distended loops of small bowel and fluid levels may be seen in the erect and head-down positions. If the atresia is of the duodenum or high jejunum, distention may be absent or negligible. Barium by mouth, as a diagnostic aid, is contraindicated, as this may clog the narrow lumen of the distal loop following anastomosis, or lead to bronchopneumonia from aspiration of the vomited barium. Clinically, attention is directed to this condition by persistent vomiting and absence of keratinized epithelium in the meconium.

Emphasis is placed on the necessity of performing a primary anastomosis to prevent loss of intestinal content through an enterostomy. Open-drop ether is used to obtain a quiet operative field. Electrolytic balance should be followed both pre- and postoperatively, and vitamin K should be administered preoperatively to combat hypoprothrombinemia.

ELLWOOD W. GODFREY, M.D.

Diverticulitis and Diverticulosis. Norman P. Henderson. Brit. J. Radiol. **17:** 197–203, July 1944.

Diverticulosis is a herniation of mucosal sacs into or through the bowel wall. Diverticulitis is an inflammation of these herniated sacs, or diverticula.

Diverticula may be congenital or may appear during or after an attack of inflammation of the bowel wall. The inflammation causes fibrosis and allows the mucosa to herniate through local points of weakness particularly at the entrance of nerves and blood vessels. Inflammation is not the only cause of diverticula. They may occur as a result of chronic constipation or in association with some other disease, such as polyposis or carcinoma. The condition is more common in men. It is most frequent in the sigmoid.

Five stages of diverticulosis may be recognized. The first stage shows on the x-ray as a "ripple" pattern at the edge of the bowel. This stage is frequently overlooked or is interpreted as spasm. The second stage shows small projecting "palisades" along the border of the bowel. [Just what is meant by "palisades" is not clear to the abstractor.] In the third stage small protruding pulsion diverticula are demonstrable. At this stage, these are retractable. In the fourth stage, which the author designates as "retractable ballooning," large retractable diverticula are seen. The fifth stage is that of permanent diverticula.

Sometimes diverticulosis is the first sign of cancer of the colon. Two illustrative cases are reported.

The disease may heal completely in any one of the first three stages. Fibrosing diverticulitis may follow the last stage, when inflammation occurs in the permanent diverticula. SYDNEY J. HAWLEY, M.D.

Cholecystography with Beta(4-Hydroxy-3,5-Diiodophenyl) Alpha Phenyl Propionic Acid. Harold C. Ochsner. Gastroenterology **3:** 23–29, July 1944.

This is another report on the use of beta(4-hydroxy-3,5-diiodophenyl) alpha phenyl propionic acid (Priodax) for cholecystography. Visualization of the gallbladder was excellent or good in 402 of 600 patients examined (67 per cent); 31, or 7.7 per cent, of these patients exhibited stones. In 81 patients (13.5 per cent) visualization was poor; and 38, or 47 per cent, of this group had demonstrable stones. In 111 patients (18.5 per cent), there was complete failure to visualize the gallbladder shadow; stones were found to be present in 37, or 34 per cent, of this group.

Aneurysm of the Abdominal Aorta with Rupture into Duodenum. Report of Three Cases. H. R. Pratt-Thomas. Am. J. Clin. Path. **14:** 405–412, July 1944.

Forty-one cases of rupture of an aneurysm of the abdominal aorta into the gastro-enteric tract have been recorded; in 32 of these, including the 3 cases reported here, the duodenum was involved. In the first of the author's cases, the clinical impression was peptic ulcer with hemorrhage and saccular aneurysm of the abdominal aorta. The patient died two hours after admission. In the second case, the clinical impression was rupture of an abdominal aortic aneurysm. Carcinoma of the stomach was also seriously considered. Both of these patients gave a history of syphilis. In neither case is any mention made of an x-ray examination. Physical and roentgen examination of the third patient showed a moderately advanced tuberculosis of the right lung with minimal involvement of the left. This patient was observed for about five years, during which there were alternating periods of improvement and exacerbation. A week before death occurred, he suddenly vomited blood and went into moderate shock. Copious black stools followed the hematemesis. No

abdominal masses were palpable. The attending physician thought the patient probably had a peptic ulcer. Tuberculosis was not believed to be a factor. An aneurysm was not considered.

Necropsy in each of the cases showed an aneurysm of the abdominal aorta with rupture into the duodenum.

THE SKELETAL SYSTEM

Lumbosacral Roentgenograms of 450 Consecutive Applicants for Heavy Work. Louis W. Breck, J. Winston Hillsman, and W. Compere Basom. Ann. Surg. **120:** 88–93, July 1944.

Because of several adverse legal decisions in cases in which pre-employment lumbosacral abnormalities had unquestionably existed, a large industrial concern established the practice of routine roentgen examination of the lower back in all applicants for work involving heavy labor. The present study is based upon the pre-employment roentgenograms of 450 consecutive applicants. In no instance was there a history of backache at the time of examination or previously.

In 86 per cent of those examined some defect was discovered. If the cases of mild wedging of the vertebral bodies and mild lumbosacral narrowing are excluded, this figure is reduced to 31 per cent. In 15 per cent the abnormalities were serious enough to render the applicant unemployable at heavy labor. An additional 8 per cent showed defects that might well lead to future difficulty.

The conditions observed are tabulated and the value of this type of examination is emphasized. [There is one obvious error in the table. The number of patients "with pathology excluding mild lumbosacral narrowing and wedging of thoracolumbar vertebrae should be 141 instead of 249 if the other figures are correct.—Ed.] ELLWOOD W. GODFREY, M.D.

Lipochondrodystrophia. Lorenzo Expósito and Argelio de Feria. Bol. Soc. cubana de pediat. **15:** 1113–1133, December 1943.

The authors present two cases of a rare disease, familial and congenital, characterized by a series of visceral and skeletal dystrophies, in which the presence of lipoid substances in almost all organs connected with body metabolism has been demonstrated postmortem. The name of lipochondrodystrophy has been applied to the condition.

The disease was first described by Hunter in 1917. Hurler, by whose name it is sometimes known, recorded 2 cases in 1919. Since then examples have been reported under different names not only in this country but abroad. In all, about 44 cases have been observed. The deposition of the lipoid substance in the tissue was first described by Tuthill in one of Hurler's cases.

The term gargoylism has been used to describe the appearance of those afflicted with the condition, because of their striking resemblance to the gargoyle. Patients bear a marked resemblance to one another. The etiology is not clear but some disturbance or congenital defect in the germinal cells is suspected.

A rather minute and extensive description of the postmortem findings is given. The most important are the abnormal lipoid infiltration and the absence of normal cartilaginous growth, which explains the many skeletal changes.

The patients are short, with a large deformed skull, short trunk and neck, deep nasal fossa, and coarse features. Other clinical evidences of the condition are kyphosis of the dorsolumbar spine, abdominal protrusion, enlarged liver and spleen, corneal opacities, and mental deficiency. The most constant findings are the skeletal changes. Changes referable to the nervous system and ocular opacities are not very constant. Ankylosis and limitation of movement of various joints are often found.

Roentgen studies of the skeleton show no abnormalities in the very young, but these appear and become pronounced as the baby becomes older and are of a chondrodystrophic nature: broadening of the bones of the arm; flattening of the anterior portion of the bodies of the vertebrae, with some backward displacement and lack of depth in the articular cavities; broadening of the ribs anteriorly and laterally with narrowing posteriorly. In some patients coxa vara, metacarpal deformities, and late ossification of the epiphyses occur. The sella turcica may be enlarged, the diaphyses, especially of the wrists, show irregularities.

The diagnosis is easy for those who have ever seen a case, for the general appearance is typical.

A. MAYORAL, M.D.

Diabetes Mellitus Associated with Albright's Syndrome (Osteitis Fibrosa Disseminata, Areas of Skin Pigmentation, and Endocrine Dysfunction with Precocious Puberty in Females). Franklin B. Peck and Charles V. Sage. Am. J. M. Sc. **208:** 35–46, July 1944.

The triad of symptoms described by Albright—osteitis fibrosa disseminata, brownish skin pigmentations, and endocrine dysfunction, with precocious puberty in females—was clearly defined and termed polyostotic fibrous dysplasia by Lichtenstein. The condition may appear in an incomplete form in that all of the signs need not be present.

The disease usually starts insidiously in childhood, and its active phase is terminated when adulthood is reached or when premature epiphyseal fusion occurs. The quiescent phase is reached slowly. The disease is not fatal or hereditary. The diagnosis rests on the clinical aspects, roentgenologic appearance, and absence of abnormalities in the blood calcium and phosphorus. Pathologically, the outstanding features are thinning of the cortex, replacement of marrow and spongiosa by dense, gritty, rubbery fibrous tissue interspersed with poorly calcified bone spicules, and absence of cyst formation. Three roentgenologic features distinguish this disease from hyperparathyroidism. (1) Areas of increased density and overgrowth of bone occur, as well as areas of decreased density. (2) The condition is not generalized, so that normal bone should be found somewhere in the skeleton. (3) The disease practically never involves the epiphyses.

The first case of diabetes in association with polyostotic fibrous dysplasia is reported in a 22-year-old white male who was admitted in severe coma. His head was asymmetric. Brownish pigmented areas were present on the skin of his back. Roentgenograms showed enlargement of the middle and outer tables of the skull, giving the calvarium a mottled appearance suggesting Paget's disease. The mandible was enlarged. Cyst-like areas were present in the pelvis. The femurs showed severe changes, with coxa vara deformities. There were old fractures of some of the ribs and of the neck of the right femur. The left tibia was in-

volved. All laboratory examinations were normal. There was slight exophthalmos, with an elevated basal metabolic rate. The thyroid was palpable.

An insulin tolerance test revealed fairly marked insulin resistance and unresponsiveness to hypoglycemia.

The appearance of severe diabetes, with enlargement of the mandible, exophthalmos, elevated basal metabolic rate and goiter all point to a common factor, the pituitary gland. In another case reported by Sternberg and Joseph there was hyperplasia of the thyroid and thymus, a narrow "lean" adrenal cortex, normal parathyroids, and a basophilic hyperplasia of the pituitary with adenoma formation. The precocious puberty in females having this disease is attributed to a hypothalamic lesion. Albright originally proposed that an embryologic defect in the hypothalamus might result in this disease. BENJAMIN COPLEMAN, M.D.

Cauda Equina Compression Syndrome with Herniated Nucleus Pulposus. A Report of Eight Cases. J. Douglas French and J. T. Payne. Ann. Surg. **120:** 73–87, July 1944.

In the authors' experience, complete or nearly complete subarachnoid block with cauda equina compression occurs much more frequently as a result of herniated nucleus pulposus than of tumor. Eight instances of subarachnoid block as manifested by myelography, are reported from a verified series of 90 cases of herniated nucleus pulposus. This represents an incidence of 8.8 per cent. The lesion occurred at the interspace of L-3 in 1 case; L-4 in 4 cases; and L-5 in 3 cases.

Back pain was present in all patients and was the symptom of longest duration. Subsequently, both legs were usually involved. Five patients complained of weakness of the legs, but this symptom was difficult to evaluate because of the pain. Disturbance of sensation in one leg was reported in 4 cases; in the saddle area and both legs in 2 cases; and in the saddle area only in 1 case. Complete retention of urine occurred in 3 cases, and of urine and feces in 1 case. Difficulty in voiding was present in 2 cases, and difficulty in voiding plus constipation in 2 others.

On physical examination atrophy of the glutei, thigh, or calf muscles was found in 4 cases, and weakness and poor muscular tone in the same areas in the remaining 4. Motor impairment was bilateral in 4 patients and unilateral in the remainder. In all instances bilateral sensory disturbances and altered reflexes were present.

Roentgenograms of the back revealed a list in 2 patients. In 5 patients, narrowing of an interspace was demonstrable, but in one of these the narrowing was not at the site of the proved lesion. Hypertrophic changes were present in 2 patients.

In all instances, complete or nearly complete block was demonstrated by myelography. It was felt that this examination was a good indication of the degree of obstruction. In one instance, abnormalities were seen at two interspaces, and at operation an extruded nucleus pulposus was found at L-5 and a protruded intervertebral disk at L-4. There were no untoward reactions to myelography. The myelograms are reproduced.

The operative findings were similar in all cases: extruded nuclei pulposi severely compressing the dural sac were encountered and removed. The dura was opened in 5 cases. No mention was made as to the condition of the intrathecal contents other than they were "elevated to a marked degree" in 2 cases; in the remaining 3 cases thickening of the arachnoid, matting of the cauda equina, and adhesions were prominently present. In 2 of these cases this was sufficiently marked that obstruction remained after removal of the extruded nucleus pulposus.

All patients were relieved of their pain postoperatively, and were ambulatory and able to void spontaneously on discharge from the hospital.

ELLWOOD W. GODFREY, M.D.

"Ring" Sequestra As a Complication of Fixed Skeletal Traction. C. P. Truog. Am. J. Roentgenol. **52:** 64–69, July 1944.

Skeletal traction in the treatment of fractures is valuable, but there are definite dangers associated with its use. Numerous authors have reported instances of osteomyelitis in cases in which such traction has been employed. The author reports 7 cases of "ring" sequestra, a complication frequently overlooked by the roentgenologist. It is believed that infection starts on the skin and extends along the pin by direct continuity to the bone. Roentgenograms show a hole in the bone made by the introduction of the pin, surrounded by a zone of bone, which in turn is surrounded by a zone of rarefaction. The ring of bone appears slightly more dense than does the surrounding bone. In all the author's cases the "ring" sequestrum developed about a pin through the upper part of the tibia probably because there is more motion of the pin here and more stress upon the bone.

The evidence indicates that "ring" sequestra are probably the result of two factors—pressure necrosis and infection. Their early diagnosis is important in order to prevent further complications. It depends entirely upon roentgen examination.

Five of the author's patients were operated upon and had filling in of new bone at the site of the sequestrectomy, while their draining sinuses healed completely. In 2 cases sequestrectomy was not performed, and draining sinuses persisted at the time of the last observation. The infection is apparently of low grade so that the typical roentgenological appearance of an osteomyelitis does not develop.

CLARENCE E. WEAVER, M.D.

Knee Injuries in Service Personnel. John H. Allan and Jesse T. Nicholson. U. S. Nav. M. Bull. **43:** 63–72, July 1944.

The authors review a series of 153 cases of knee injury exclusive of compound wounds, which received treatment aboard a hospital ship. Ninety-eight patients were hospitalized; 55 were treated as out-patients; 15 were received for convalescence following operative treatment elsewhere, and 44 arthrotomies were done aboard ship.

The authors' statistics indicate that 55 per cent of knee injuries occurred in patients between the ages of twenty and twenty-five years. Thirty-three per cent of those treated surgically had histories of knee injuries prior to entry into the service and 67 per cent had had symptoms for more than one month. A twisting force to the knee was the most frequent source of trouble. The most common injuries encountered were traumatic synovitis, injuries to the internal semilunar cartilage, and sprains of the internal lateral ligaments.

The chief diagnostic problem is to determine whether or not there exists an internal derangement which requires surgical intervention. Roentgen examination was made in all cases in which there was a history of trauma and in all cases in which surgery was indicated. A diagnosis of a cartilage lesion was difficult immediately after the initial injury.

Procaine was efficacious in the treatment of muscular strain but not in ligament strains about the knee. Operation was reserved for cases with evidence of internal derangement. The duration of postoperative convalescence was in proportion to the degree of surgical trauma: the removal of the displaced fragment of a fractured cartilage gave a shorter convalescence than when the entire meniscus was removed. Parapatella incisions prolonged convalescence. Early use of the quadriceps was found to be imperative for a short convalescence. Repeated aspiration for postoperative effusion is recommended. Disability in acute synovitis averaged sixteen days; in sprain of internal lateral ligaments, six weeks; following an arthrotomy, twenty-four days.

The authors recommend that at front-line hospitals with limited surgical facilities elective knee surgery be deferred. Such operations are best done at the locality at which the entire period of convalescence can be controlled. H. T. GUARE, M.D.

Injuries to the Ligaments of the Knee Joint. Leroy C. Abbott, John B. de C. Saunders, Frederic C. Bost, and Carl E. Anderson. J. Bone & Joint Surg. **26:** 503–521, July 1944.

This is an extensive study of the movements and ligaments of the knee joint. The anatomy is reviewed and the relation of the ligaments to the motions of the knee in various positions is described.

Roentgen examination is of value if a piece of cortex is separated from the bone as a result of pull on a ligament. Also in rupture of the tibial collateral ligament, films will show widening of the joint space on the medial aspect. JOHN B. MCANENY, M.D.

Traumatic Synostosis of the Distal Third of the Radius and Ulna. Floyd Hurt and Spencer C. Flo. Surgery **15:** 894–898, June 1944.

Congenital synostosis of the proximal third of the radius and ulna is not uncommon, more than 200 cases having been reported. Traumatic synostosis of the shaft, however, seems to be a rare abnormality. Only two cases were found in the literature. The case here reported is interesting because the exostosis apparently arose equally from the radius and ulna, forming a pseudarthrosis. There was no apparent narrowing of the interosseous space, and the original fracture, which dated back some years, was in good position. Portions of the exostosis not removed at operation showed gradual absorption rather than regeneration. The etiology is not clear but the condition is believed to have been due to injury of the radius and ulna with a probable subperiosteal hematoma and deposition of bone cells within the clot.

The patient was a 27-year-old soldier who complained of a painful left forearm. He had been struck by a hammer a number of years before and had been told that his arm was broken. A splint had been applied, but no manipulation was attempted and no roentgenograms were taken. There was satisfactory motion after removal of the splints but a gradual diminution of rotation was noted in successive years with fixation in midpronation for the last two years. On palpation a bony formation could be felt on the flexor surface of the forearm about 6 cm. proximal to the wrist joint. X-ray films revealed a bony bridge at this point, measuring 1.5 × 3.0 cm. joining the radius and ulna. At operation a definite line of cleavage was found in the center of the bridge, corresponding to the pseudarthrosis noted on the film. Following operation the arm could be rotated freely, although x-rays showed a small portion of the bony bridge remaining on the radial side. Two months later this portion of the bridge appeared smaller and all loose fragments of bone were absorbed, except one. This was removed at a second operation.

J. E. WHITELEATHER, M.D.

Fatigue Fractures. Percival A. Robin and Samuel B. Thompson. J. Bone & Joint Surg. **26:** 557–559, July 1944.

Within sixteen months, 15 cases of insufficiency fractures of bones other than metatarsals were encountered. Thirteen involved the tibia, one the femur and one the pubic bone. There were bilateral tibial fractures and one tibial fracture was multiple. The usual history was generalized aching pain over the fracture site following an extended march. In the later stages a palpable mass as a result of callus was present.

The earliest x-ray finding was infraction of the cortex. After one or two weeks new bone formation was seen. The fracture line disappeared in about one month. Treatment consisted in rest followed by walking with crutches until union occurred.

One important finding seems to be the long delay in discovery of the injury, which was on the average 31.4 days. The average hospital stay was 41.3 days. Six patients returned with the same complaint, but no reason could be found for the recurrence of symptoms.

JOHN B. MCANENY, M.D.

Subtalar Dislocation. L. W. Plewes and K. G. McKelvey. J. Bone & Joint Surg. **26:** 585–588, July 1944.

It is believed that subtalar dislocation is still sufficiently rare to warrant case reports. Up to the time of this report 155 cases had been recorded. Males predominate in a 6 to 1 ratio and the condition occurs most frequently in the third decade.

An interesting feature is the failure of aseptic necrosis to develop after this severe injury, where seemingly the entire blood supply must be destroyed, though this bone shows an aseptic necrosis after a slight crush injury.

Two case reports are presented, with reproductions of roentgenograms. In one patient great difficulty was encountered in reduction, while in the other case reduction by manipulation was easy.

JOHN B. MCANENY, M.D.

Spinal Extradural Cyst (Diverticulum of the Spinal Arachnoid). C. Allen Good, Alfred W. Adson, and Kenneth H. Abbott. Am. J. Roentgenol. **52:** 53–56, July 1944.

A case of spinal extradural cyst seen by the authors is the twenty-first instance of this condition to be recorded. Adelstein's (J. Bone & Joint Surg. **23:** 93, 1941) review of 17 cases including one of his own is

cited, and references to 3 additional cases are furnished.

The authors' patient, a man of forty-two, experienced weakness and stiffness in the left leg, and a little later in the right. There was sensory loss in the lower extremities. Atrophy in those muscles supplied by the second to the fifth lumbar and the sacral nerves was present on the left. Deep reflexes were hyperactive on both sides. Lumbar puncture disclosed incomplete subarachnoid block. Roentgenograms of the lower thoracic and lumbar regions showed erosion of the pedicles of the eleventh and twelfth thoracic vertebrae. Films made following the introduction of radiopaque oil into the lumbar subarachnoid space demonstrated a complete block opposite the eleventh thoracic interspace. A lateral view showed extradural oil posteriorly and revealed the communication between the cyst and the subdural space. The cyst was removed surgically.

Almost all the reported instances of spinal extradural cyst have been in adolescents. Male patients outnumber female patients four to one. Most of the cysts have been located in the middle or lower thoracic region. Spasticity and weakness are noted at the onset in the lower extremity on the same side as the cyst; later the opposite lower extremity is affected. Pain is usually absent. Manometric tests often show either partial or complete block to the flow of cerebrospinal fluid, and an increase of the total protein content of the spinal fluid may be noted.

Roentgenograms may show changes which are pathognomonic. Enlargements of the spinal canal, together with the changes of kyphosis dorsalis juvenilis in the bodies of the involved vertebrae, are not found in any other condition. If only the history and physical examination are taken into consideration, the condition may be confused with multiple sclerosis or other degenerative processes.

Roentgenograms and drawings are furnished to illustrate the diagnostic signs and the pathological findings in the reported case.

CLARENCE E. WEAVER, M.D.

GYNECOLOGY AND OBSTETRICS

Salpingitis and Tubal Patency. Frederick L. Schwartz. Am. J. Surg. **65:** 65–73, July 1944.

The relative merits of gas insufflation and hysterosalpingography in determining tubal patency are discussed. The author concludes that hysterosalpingography, when properly done, even in the presence of salpingitis, carries nomore risk than any other diagnostic procedure, and while it is subject to more possible complications, the morbidity is negligible. In his opinion hysterosalpingography is superior to insufflation from both the diagnostic and therapeutic standpoint.

One hundred and sixty-five salpingograms were reviewed. All of these films were made as an office procedure and in no instance was there reaction sufficient to prevent the patient coming in for a 24-hour film or from carrying on her regular occupation. All injections were made through a soft-tipped cannula without manometric control. After 3 to 4 c.c. of oil had been injected slowly and gently, a film was exposed, developed, and viewed. Injection was discontinued and a film made, regardless of the amount of oil injected, if the patient complained of severe pain. The series included both sterility studies and examinations of patients with recurrent salpingitis who desired children.

Of this series of 165 patients, 12 became pregnant; in 18 cases a bilateral salpingectomy was done. In all patients subjected to surgery, the findings were confirmed by tissue examination and in all relief of symptoms was obtained. In none of the operated cases was there found any evidence of irritation from the iodized oil.

Salpingitis may be present even though a tube is permeable. Such tubes present certain characteristic radiologic features, such as elongation, clubbing and redundancy at the extremity, and areas of stenosis and dilatation.

In a number of cases, with a record of previous varied treatments, symptoms were relieved by hysterosalpingography.

THE GENITO-URINARY TRACT

Perirenal Abscess with Extension into the Right Pleural Cavity Following Rupture of Right Renal Pelvis: Operative Findings and Results. Neil S. Moore and Harry H. McCarthy. J. Urol. **52:** 17–22, July 1944.

A case is reported of a right perirenal abscess with extension into the right pleural cavity by transdiaphragmatic fistula. In 1940 the patient had a sudden onset of right flank pain with fever, leukocytosis, and white cells in the urine. Retrograde pyelography showed poor filling of the right renal pelvis, with stones in the inferior calices and in the upper portion of the right ureter. Operation was refused.

Three and one-half years later the patient returned with pain in the right loin and right lower chest, fever, and cough. There were white cells in the urine and the white blood count was 10,000. A dense shadow obliterated the right lower lung field, with some fluid above it. Thoracentesis yielded pus containing a gram-negative bacillus and a few pneumococci. Retrograde pyelography, with methylene blue added to the radiopaque substance, showed a large extrarenal area filled with the dye in the right paravertebral region. Three days later fluid obtained on thoracentesis was tinted blue. Intravenous urography showed a bilaterally functioning urinary tract with extravasation of the dye into the extrarenal area described above.

At operation, a large perirenal abscess was found to communicate with the renal pelvis through a small tear in the latter. The perforation in the pelvis was sutured, the abscess drained, and the sinus tract cauterized. Recovery was uneventful.

A chest film nineteen days after operation showed only slight thickening of the pleura at the right base. It would seem unlikely that a true empyema would resolve so rapidly even under modern chemotherapy.

J. FRANCIS MAHONEY, M.D.

Actinomycosis of the Kidney; Report of a Primary Case. Charles P Mathé. Urol. & Cutan. Rev. **48:** 313–318, July 1944.

Actinomycosis of the kidney is rare. It occurs predominantly in middle life and in the male. As a rule, the kidney acts as a filter, eliminating the ray fungus from the body, but when renal resistance is lowered by trauma, stone formation, obstruction, infection, etc., colonization of the fungi is favored. Perinephric abscess is a frequent complication.

Renal actinomycosis may be primary or secondary.

The kidney may be involved by direct extension from contiguous structures, as the lungs, intestines, or bladder, or by way of the blood stream. The symptoms are those of any encapsulated infection—fever, loss of weight, anorexia, and weakness—with local tenderness and swelling. The presence of a mass in the loin is not specific for actinomycosis.

In the early stages, pyelography is unreliable. In the presence of advanced disease, it may reveal pressure defects in the calices and pelvis, which are strongly suggestive of neoplastic growth. Positive x-ray signs of cortical and perinephric abscess are usually present, namely renal fixation and obliteration of the psoas muscle shadow, and should suggest the possibility of actinomycosis if tuberculosis and tumor can be excluded.

Sulfur granules may sometimes be present in the urine or in pus from a discharging sinus tract. Isolation of the ray fungus, which requires special anaerobic culture methods, establishes the diagnosis. Nephrectomy is indicated, in two stages if there is a complicating perinephric abscess.

The author reports a case of primary actinomycosis in a calculous kidney, complicated by prostatic abscess and perinephric abscess. It is believed that the organisms were carried to the kidney by the blood stream and that their entrance into the cortex was facilitated by devitalized tissue due to stone formation. Ureterolithotomy, prostatotomy, and drainage of the perinephric abscess were performed. Recovery of the ray fungus from the material drained from the abscess eventually led to the diagnosis, and a two-stage nephrectomy was successfully performed. Once the diagnosis was established, the patient was given large doses of iodides and chiniofon.

MAURICE D. SACHS, M.D.

RADIOTHERAPY

NEOPLASMS

Recent Advances in the Treatment of Carcinoma of the Mouth and Jaws. T. H. Somervell. Brit. J. Surg. **32:** 35–43, July 1944.

The author has had the unusual experience of treating 4,853 patients suffering from malignant neoplasms of the mouth, including cheek, lips, tongue, and jaws, during a twenty-year period in a 200-bed mission hospital located in South India. Out of a total of 10,480 operations for malignant neoplasms performed in this hospital during the years 1923–1942, inclusive, 8,439 were done for epithelioma of the mouth. The large number of cases of buccal carcinoma encountered can be explained by the habit of the natives of chewing betel nut mixed with lime and tobacco, especially the strong Vadakkan tobacco of South India and that of Jaffna, Ceylon.

Of the 4,853 cases comprising the series reported, 52 per cent involved the cheek and lips, 28 per cent the lower jaw, 7 per cent the upper jaw, and 13 per cent the tongue. The greater proportion of the cases arise in the cheek. From the cheek the growth, if neglected, spreads in a few weeks to one or both jaws. From the tongue such spread is far more rare, occurring only in a very late stage.

The author is strongly opposed to use of deep x-ray therapy for cancer of the mouth because of the high probability of local recurrence. In addition to this, the ill effects on the general health may reduce the patient to a condition in which he cannot stand further treatment. On the whole, operation is advised for all cases of carcinoma of upper and lower jaws. Radium is considered the best treatment for cancer of tongue or cheek in conjunction with diathermy or operative removal of large fungating growths, cancer of the whole tongue, and epithelioma of the leukoplakic type in tongue or cheek.

In general, growths of the cheek are fairly sensitive to radium, except when they are very superficial and of the leukoplakic type. Radium needles of 1 cm. active length, each containing 1 mg. of radium element, placed 1 cm. apart, may be left in the cheek for ten days. The regional lymph nodes are removed following treatment of the primary lesion in every case, and extraction of teeth contiguous to the growth is done at the same time, never before radium insertion. The prognosis of radium-treated carcinomata of the cheek is very good, so long as radiation is sufficient, and upon this latter point the author lays special stress. Two or three weeks after treatment, the cheek must be examined; the presence of a superficial ulcer at this time, extending over the whole area occupied by the growth and a little beyond it, means that dosage has been adequate.

For lesions located in the side of the tongue, 4-cm. radium needles of 2 mg. strength are used. Most of the needles are inserted at the border of the palpable growth. If the growth is entirely confined to one side of the tongue, a unilateral block dissection of submental, submaxillary, and deep cervical nodes is sufficient. A lesion at the tip of the tongue is best removed by diathermy with irradiation of the base of the wound with short needles inserted transversely. Large soft lesions in the back of the tongue require long needles with high dosage for a short time. When the floor of the mouth is involved, the radium is inserted within the mouth, parallel to the long axis of the tongue, and from without, just inside the edge of the mandible. The cervical nodes are removed later. When the epiglottis and the tonsil region are involved, deep x-ray therapy combined with insertion of long radium needles into the deeper parts of the growth and into the tonsil itself offers a chance of cure.

The author describes his operative methods and makes a plea for closer cooperation between the radiologist and the surgeon. A mortality table is appended showing only 0.2 per cent hospital deaths in cancer of the cheek and lips, 2.0 per cent for cancer of the tongue, 3.4 per cent for cancer of the upper jaw, 8.5 per cent for cancer of the lower jaw. MAX CLIMAN, M.D.

A Consideration of Dose Distributions in the Treatment of Intrinsic Carcinoma of the Larynx by Radium Implantation. J. Morton, L. H. Gray, and G. J. Neary. Brit. J. Radiol. **17:** 204–212, July 1944.

Studies of the dose distribution in the Harmer and Finzi technic of irradiation of laryngeal cancer were made in fixed anatomical specimens by ionization measurements.

The original methods of fenestration showed that the anterior portion of the ventricular fold received 7,250 r, the middle of the fold 5,000 r, and the posterior portion 3,300 r. Points below the ventricular fold were inadequately irradiated. By modifying the technic by removing a narrow strip of the cricoid, a slightly better distribution is obtained, but the dose falls off posteriorly. A better distribution can be had by placing one needle horizontally and by irregular filling of the needles.

The results of the study are shown in diagrams and tables that should be consulted in the original.

SYDNEY J. HAWLEY, M.D.

Thymic Region Tumors with Acute Leukemia. N. Puente Duany and A. Castellanos. Rev. med. cubana **54:** 1062, December 1943; **55:** 69 and 152, January and February 1944.

One hundred reported cases of tumors in the region of the thymus with leukemic changes are reviewed, and two new cases are added. These tumors are of two clinical types—one producing symptoms of compression and the other not. In either event the blood picture may show an increase in the number of leukocytes (the hyperleukocytic type), a decrease (the leukopenic type), or a normal count (aleukemic type).

In treating these tumors with x-rays, great care should be exercised, as the thymus is extremely radiosensitive and responds favorably to small doses. Typical leukemia has been known to follow x-ray treatment of tumors of the aleukemic type.

A. MAYORAL, M.D.

Some Experiences in the Treatment of Bronchial Cancer. Walter L. Mattick. Am. J. Roentgenol. **52:** 24–30, July 1944.

From a therapeutic point of view, the most we can expect to achieve in the presence of bronchial carcinoma is to maintain the resistance of the host while we attempt to render innocuous the malignant growth, either by surgical extirpation or radiation sterilization or by both, so as to prevent further dissemination. Therapy, therefore, to achieve beneficial results should be begun early in the course of the disease, before generalized metastasis has taken place.

To date the best results from radiation therapy of bronchial cancer, in the author's experience, seem to have been achieved with 200 kv., with cross-firing to build up a total dose of 12,000 r, with properly directed and angulated portals, distributed over two anterior and two posterior fields. A supplemental course of similar irradiation may be given after one or two months, through previously unirradiated portals, probably three in number, in order to cross-fire into the site of the lesion. In a few selected cases where the intrabronchial tumor is accessible, gold radon seeds may be implanted through the bronchoscope. In the supervoltage range it would seem from the author's experience so far that good results may be expected especially with 400 kv. With 1,000 kv. the results have not been encouraging.

Four cases are reported, in each of which a histopathologically proved malignant growth in the bronchus has apparently disappeared, as judged by bronchoscopic examination, under radiation therapy, with no recurrence over a period sufficient to make one hopeful that such therapy may and will, if skillfully managed, accomplish lasting results. These cases constitute 3 per cent of a series of 147 treated. The author feels that the results he has obtained are generally more optimistic than many reports on the surgical, radiation, or combined treatment of this condition appearing in the recent literature.

CLARENCE E. WEAVER, M.D.

Osseous Metastases from Graded Cancers of the Breast, with Particular Reference to Roentgen Treatment. Hobart A. Burch. Am. J. Roentgenol. **52:** 1–23, July 1944.

Of all the metastatic malignant lesions in bone, those secondary to cancer of the breast are the most common. On the basis of the evidence in hand, it would seem that metastasis to bone can undoubtedly occur by way of either the blood or lymph channels, although the arguments of von Recklinghausen and his supporters in favor of embolic dissemination through the blood stream appear as yet the more alluring and suggest the latter as the more usual route.

Bone metastases from cancer of the breast are predominantly of the osteoclastic type. Pain is usually the first warning, clinically, of bone involvement. It is of two types: local pain, originating through pressure on the periosteum or on the sensory nerves that supply it, and neuralgic pain, arising from pressure on adjacent nerves. Not rarely the first indication of a metastasis is the occurrence of a pathologic fracture. Pain may precede the roentgen evidence of metastases by several months.

The present study was undertaken principally to determine the bearing which the type of the primary breast cancer might have upon the time of occurrence of bone metastases and their response to roentgen therapy. It is based upon 41 cases with metastases in the the spine and pelvis. Broders' system of grading was followed. In no instance in the group of 41 patients used for the study was the primary tumor of Grade 1.

From the observations made on these patients the inference suggests itself that the occurrence of bone metastases from various grades of cancer is roughly proportional to the frequency with which those grades occur in the breast. In general, the lower the grade of malignancy of the primary carcinoma, the longer the duration of life before metastasis to the vertebrae or pelvis occurs. In breast cancer of the same grade, (*a*) the younger the patient, the earlier the osseous metastases, and (*b*) the greater the degree of axillary node involvement found at operation, the earlier the appearance of metastatic bone lesions. The location and number of bone lesions apparently bear no relation to the grade of malignancy. They were multiple in approximately two-thirds of the cases of each group. It is impossible to determine the grade of malignancy of the primary lesion on the basis of the roentgen appearance of its osseous metastases.

Relief from pain by roentgen therapy is probably due to retrogression of the metastatic process and destruction of inflammatory tissue at the periphery of the metastatic lesion. In the 41 patients in this study treated for relief of pain, some degree of analgesia was obtained in 35, or 85.3 per cent. Six experienced no relief. In 29, or 70.7 per cent, of the 41 cases the relief was considerable or complete; in 14, or 34.1 per cent, it was complete. Although the higher degrees of relief from roentgen therapy were somewhat more frequent in the Grade 2 and Grade 3 groups than in the Grade 4 group, the likelihood of obtaining some degree

of initial relief was about as great in one group as another. The more favorable response to roentgen therapy, in point of both type and duration of relief, was seen to a greater extent among patients with the lower grades of malignancy. The 35 patients obtaining relief of one type or another came to treatment in an average of three to four and a half months after onset of symptoms; the 6 patients obtaining no relief came for treatment in an average time of 8.5 months after onset of symptoms of bone metastasis. It seems that although relief of any type and any duration can occur in cases of any group, the more favorable responses in point of degree and duration will be seen more often among patients with neoplasms of the lower grades. The history of failures seems to point to the advisability of treating early and treating adequately. It is suggested that in the treatment of the pelvic region multiple beams of high-voltage radiation directed from a minimum of four angles offer the best chance of palliation. The lower the grade of malignancy, the longer the duration of life after the occurrence of bone metastases and after their roentgen treatment. Although palliation was all that was expected, there was undoubtedly prolongation of life in certain individual cases. CLARENCE E. WEAVER, M.D.

NON-NEOPLASTIC CONDITIONS

Local Use of Sulfadiazine Solution, Radon, Tyrothricin, and Penicillin in Otolaryngology. S. J. Crowe. Ann. Otol., Rhin. & Laryng. **53:** 227–241, June 1944.

In many members of the Armed Forces in the tropics, as well as those in colder and damper climates, there develops an excessive hyperplasia of lymphoid tissue in the pharynx and nasopharynx, predisposing to frequent colds, chronic nasal congestion, and postnasal discharge. In men subjected to great changes in pressure, as aviators and submarine crews, the ear and sinus lesions may be purely mechanical. In the presence of an acute or chronic infection in the upper air passages, however, these pressure changes often lead to suppuration, necessitating hospitalization and even discharge from service.

Two simple and practical methods of treatment are helpful; (1) local application of a sulfadiazine solution in the nose and nasopharynx to discourage the growth of bacteria and (2) beta and gamma irradiation of the pharynx and nasopharynx to remove hyperplastic tissue. The sulfadiazine gives only temporary relief. The real problem is to get rid of the excess lymphoid tissue. The combination of the two measures is often better than either alone.

Next to the sex cells, lymphocytes are the most radiosensitive cells in the body. Small doses are therefore effective, and danger of burns or of a dry nasopharynx with crust formation is minimal. The action of the radiation is to inhibit mitosis in the germinal centers and thus stop the formation of new lymphocytes.

The author, working in the Johns Hopkins Hospital, uses from 800 to 1,000 millicuries of radon with a brass filter 1 mm. in thickness, but he recommends a more practical technic for use in the Army as well as in civilian hospitals and office practice. This employs an applicator made of monel metal, with a handle 15 cm. long and a chamber 15 mm. long, 1.5 mm. in diameter, and 1.5 mm. in thickness, containing 50 mg. of anhydrous radium sulfate. The results of this technic in 259 children have been as good as with radon, and the time required for each treatment is only 6.6 minutes. Hearing was improved in a high percentage of cases; a chronic discharge ceased in 15 patients, and 15 with a history of repeated attacks of acute otitis media remained well after irradiation.

A thorough inspection, with a nasopharyngoscope, of the nasal passages, the orifices of the accessory nasal sinuses, and particularly the nasopharynx and orifice of the eustachian tubes, should precede irradiation. The teeth, pharynx, tonsils, and the base of the tongue must be examined. Treatments should be spaced at intervals of four to five weeks. Often only one treatment is necessary, but the nasopharynx should always be re-examined six months later. If any symptoms or visual evidences of recurrence are found, irradiation is repeated. Greatly enlarged adenoids are better treated by operative removal, supplemented by irradiation at the conclusion of the operation.

At the Johns Hopkins Hospital, approximately 125 patients are treated each month in the out-patient department with beta and gamma irradiation of the nasopharynx. It has been the practice to irradiate the nasopharynx only. If the this is freed of lymphoid tissue, recurrent colds become less frequent and severe, and infections in the sinuses, ears, and tonsils often heal spontaneously.

The author outlines protective measures for the operator and discusses also the use of penicillin and tyrothricin for local application. The latter he considers in many ways superior to either penicillin or the sulfonamide powders. STEPHEN N. TAGER, M.D.

Treatment of Impaired Hearing by Radiation of Excessive Lymphoid Tissue in the Nasopharynx. Henry D. Rentschler and John W. Settle, Jr. Pennsylvania M. J. **47:** 985–988, July 1944.

Impaired hearing in children is most often caused by adenoid tissue which blocks the eustachian tubes. The best treatment for this condition is removal of the tonsils and adenoids. If there is a recurrence of excessive lymphoid tissue along the lateral walls and around the eustachian tubes, irradiation should be employed, as lymphoid tissue is the most radiosensitive of all tissues.

The author believes that radium is superior to x-rays in the treatment of this condition because it can be placed in the area where treatment is required and normal tissue does not have to be irradiated. He also finds it difficult to have a child lie still for deep therapy.

The method of Crowe and Baylor is used for radium therapy. The radium or radon is contained in a brass capsule 1 mm. thick and 2 cm. in length, with a handle 13 cm. long. The applicator is passed through the nose and the capsule brought to lie in the region of the fossa of Rosenmüller. A dose of 2 gram-minutes is given to either side and may be repeated at monthly intervals without deleterious effect on the normal tissues.

Where deep roentgen therapy is given, the author uses 200 kv. with a filter of 1 mm. Cu + 1 mm. Al, at 50 cm. distance. Two 6 × 8-cm. lateral facial ports are used, 100 r (measured in air) being given to each portal daily until each has received 400 r. This will give about 260 r to each fossa.

The author has treated 35 patients with excessive lymphoid tissue in the nasopharyngeal region, of whom 19 had impaired hearing and middle ear disease. All except 4 of this group showed improvement. Those that did not improve were adults with long standing infection. JOSEPH T. DANZER, M.D.